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ILLINOIS INSECTICIDE EVALUATIONS FIELD AND FORAGE CROPS

1986

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ILLINOIS INSECTICIDE EVALUATIONS - 1986

Field and Forage Crops

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PREFACE

The information included in this report represents an expanded effort by investigators at the University of Illinois and the Illinois Natural History Survey to evaluate the efficacy of numerous insecticides and certain biological organisms against several insect pests of field and forage crops. The results from these and similar trials conducted throughout the Midwest will be used to help us develop suggestions for insect management in Illinois.

Each major section of this report includes introductory material, a discussion of methods and materials we used to conduct the trials, plot descriptions and experimental design, results, and a discussion about how we interpreted the results. Most of the results are also presented in tables included with the text. We have tried to be as complete and objective as possible throughout the report.

Trade names, when known, have been used throughout the report. However, their use does not constitute an endorsement by the University of Illinois or the Illinois Natural History Survey. Many of the products included in this report are not yet fully registered for the uses discussed herein, so their use outside of an experimental context would be illegal.

ACKNOWLEDGEMENTS

We want to thank Chip Guse and Ellen Brewer for their assistance and patience in helping sort through the technical and statistical portions of this report. We also want to thank Pat Porter and Dick Bonham for their excellent help during the 1986 growing season. Special thanks are due the growers, county Extension advisers, farm managers, aerial applicators, and the many other cooperators who helped during 1986. Many of these same people also found the time to help us with our "root digs" during July. We sincerely appreciate all of the assistance and cooperation we received.

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CONTENTS

POTATO LEAFHOPPER CONTROL AND THE EFFECT OF INSECTICIDES ON SELECTED PREDATORS AND PARASITES

Principal Investigators: Karl Kinney, Keith Hunter, and Doyle Dazey

Location: University of Illinois Horticulture Farm, Urbana, Illinois

Objectives: The objectives of this study were to evaluate Lorsban and two formulations of Furadan for control of the potato leafhopper, *Empoasca fabae* (Harris), and to determine the effect of these products on selected predators and parasites.

INTRODUCTION

The potato leafhopper (PLH) is the most serious insect pest of alfalfa in the midwestern United States. The PLH does not overwinter in Illinois, but rather is carried into the state each spring by storm systems originating in the gulf states. The arrival of this pest usually coincides with the first cutting of alfalfa in Illinois. As a result, producers are most concerned with PLH damage to alfalfa prior to the second and third cuttings. Steffey (1987) presents a more thorough review of the PLH and its impact as a pest of alfalfa.

Producers can increase their yields, improve the quality of the alfalfa hay, and reduce plant stress by managing the PLH (Wilson 1982). Management typically involves: (1) sweep-net samples to estimate the PLH population present in the field, (2) consideration of PLH population samples and plant height in order to determine if an economically damaging population exists, and (3) treatment with an insecticide if the economic threshold is reached.

In most cases, populations of predators and parasites are also affected when an insecticide is applied. Predators and parasites may delay or reduce the potential for pest populations to achieve economic thresholds. As a consequence, it is important to assess the impact that insecticides might have on predators and parasites.

During the summer of 1986, investigators at the Illinois Natural History Survey established insecticide tests to evaluate several products for control of the PLH in alfalfa prior to the third cutting. Sweep-net samples were used to estimate the actual number of PLH present prior to treatment and to estimate the impact the insecticides had on PLH control and on selected predators and parasites.

METHODS

The PLH insecticide evaluations were conducted in a 4-year-old stand of alfalfa (approximately 2 acres) located at the University of Illinois Horticulture Farm in Urbana, Illinois. A randomized complete block design with four replications was used to assign treatments to specific plots. Each plot measured 50-feet by 50-feet square, and all blocks were separated by a 20-foot border of untreated alfalfa.

On 25 July, 1986, at 8:00 am, pre-treatment populations of PLH were sampled by taking 20 pendulum sweeps from each plot with a 15-inch diameter sweep net. The numbers of PLH nymphs and adults per sweep were counted and are reported as an average for all 4 replications for each treatment (Table 1). These samples were taken 2 weeks prior to the 3rd cutting when the alfalfa was 12-14 inches tall. No estimates of the populations of predators and parasites were recorded before the treatments were made.

Insecticide applications were made on 25 July, 1986, at 5:00 pm when daily winds were minimal. Insecticides were distributed through a 10-foot boom mounted on the rear of a John Deere 3020 tractor and powered by a compressed air system calibrated to deliver 11 gpa of finished spray at 40 psi. TeeJet^R (XR8003) nozzles were placed at 20-inch centers on the boom and the boom height was 17-19 inches above the ground during application. The ground speed during the insecticide applications was 4 mph.

Post-treatment samples were taken on 28 July, and on 1, 4, and 8 August (3, 6, 9, and 13 days post-treatment, respectively). All post-treatment samples were taken as previously described. However, the insect samples were transferred from the sweep net into Zip-Lock^R freezer bags and were frozen as quickly as possible so that counting and identification of the insects in the samples could be conducted at a later date.

RESULTS AND DISCUSSION

After the insecticide treatments were applied to the plots, approximately 0.10 inch of rain fell overnight (Appendix A-1). An additional accumulation of 0.58 inch of rainfall was recorded between 26 July and 8 August when sampling was discontinued (Appendix A-2). This amount of moisture was not considered significant enough to have interfered with the insecticide treatments.

The economic threshold for PLH in Illinois when the alfalfa is 12 inches or taller is 1.5 PLH/sweep. Although the pre-treatment counts of PLH averaged 1.16 PLH/sweep (nymphs and adults), slightly below the economic threshold, the study did generate some useful data about reductions of PLH in alfalfa (Table 1).

Potato leafhoppers: All insecticide treatments significantly reduced PLH populations for at least 9 days post-treatment when compared to the numbers of PLH in the untreated check (Table 1). However, the numbers of PLH in all plots increased to levels that exceeded the economic threshold by 9 days post-treatment, and then decreased noticeably by 13 days post-treatment. We could not thoroughly explain these population fluctuations.

Furadan 4F provided significantly better control than Lorsban 4E on the first post-treatment sampling date and numerically better control than Furadan 90DB/WSB (water soluble bag). Although there were numerical differences in PLH numbers among the insecticide treatments on subsequent sampling dates, the differences were not statistically significant beyond 3 days post-treatment.

Predators and parasites: The data for populations of predators and parasites in this trial reveal some significant differences in numbers among the various treatments. However, because pre-treatment samples for these animals were not taken, we cannot necessarily attribute these differences to treatment effects. Nevertheless, some trends were apparent.

All insecticide treatments seemed to reduce coccinellid (ladybird beetles) populations (both larvae and adults) for at least 9 days post-treatment (Table 2A). Spider populations were also significantly reduced in the insecticide-treated plots for 3 days post-treatment, but these significant differences were not apparent on subsequent sampling dates (Table 2A). Very few lacewings were collected during the sampling periods, and the data, when summarized, were rather ambiguous regarding the effect the treatments might have had on this predatory group (Table 2A).

Furadan 90DB/WSB and Lorsban 4E significantly reduced the nabid (damsel bug) population for at least 13 days post-treatment when compared to the numbers of nabids in the untreated check (Table 2B). Furadan 4F significantly reduced the nabid population for at least 9 days post-treatment.

There were no statistical differences in estimates of minute pirate bug populations among treatments on any sampling date (Table 2B). Of all the predators and parasites examined in this study, the minute pirate bug population seemed to be the least affected by the insecticide treatments.

Members from a number of families of parasitic Hymenoptera were recovered on post-treatment sampling dates. The following is a list of those families in the order of frequency of recovery in the samples: Eulophidae, Braconidae, Encyrtidae, Scelionidae, Pteromalidae, Ichneumonidae, Platygastridae, and Dryinidae. The parasitic Hymenoptera, as a group, seemed to be significantly affected by the insecticides for at least 3 days post-treatment. However, significant differences in estimates of populations of parasitic Hymenoptera were not apparent by 6 days post-treatment and beyond. No attempt was made to look at the insecticide effect on specific families.

It is worth reiterating that these results reflect only estimates of actual populations. There are more effecient ways to sample for many of these insects. For example, aspirators are frequently used to recover minute pirate bugs and this technique is a more efficient estimate of those populations than the sweep-net recovery technique. Despite these limitations, the sweep-net samples are a relative measure of populations during a specific window in time and provide useful estimates for many of the insects likely to be affected by insecticide treatments.

One final point worth mentioning is the apparent increase in most insect populations sampled during the study. Over the course of the post-treatment samples, there were numerical and sometimes statistical differences in populations, and the numbers in the untreated plots typically were larger. However, all populations sampled (including those in the untreated plots) seemed to peak on 4 August and then decreased by 8 August (Tables 1, 2A, and 2B).

CONCLUSIONS

Furadan 4F seemed to reduce PLH populations more effectively than did Furadan 90DB/WSB or Lorsaban 4E, although all three of the products were generally effective in reducing PLH populations. PLH populations increased above the economic threshold by 9 days post-treatment for all products tested, suggesting that these insecticides did not remain effective for much longer than a week. This clearly points out the importance of timing insecticide applications after PLH populations exceed the economic threshold. Even then, continued monitoring of PLH populations is recommended to detect any increase in numbers.

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Wilson, M.C. 1982. Improving alfalfa forage quality: How to detect and manage the potato leafhopper problem. Certified Alfalfa Seed Council, Woodland, CA. 4 pp.

Table 1. Treatment means for the potato leafhopper insecticide evaluation in alfalfa, University of Illinois Horticulture Farm, Urbana, Illinois, 1986.

			Mean number of PLH/sweep[1]				
				days post-treatment			
Product	Rate[2]	Method of application	pre-trt	3	6	9	13
Furadan 4F	0.5	broadcast	1.21a	0.09a	0.66a	2.81a	0.89a
Furadan 90DB/WSB	0.5	broadcast	1.11a	0.39ab	0.91a	3.48a	1.18a
Lorsban 4E	0.5	broadcast	1.16a	0.90b	0.97a	3.62a	0.78a
Untreated check	...	...	1.16a	2.49c	1.80b	5.08b	1.53a

[1] Means in a column followed by the same letter are not significantly different (DMRT, p=0.05).

[2] Rate expressed as pounds of active ingredient per acre (lb. ai/A).

Table 2A. The effect of Furadan and Lorsban on selected predators and parasites in alfalfa.

Treatment	lb (AI)/ acre	Mean no./sweep on days following treatment[1,2] Coccinellids 3	6	9	13	Spiders 3	6	9	13	Lacewings 3	6	9	13
Furadan 4F	0.5	0.01ab	0.04a	0.29a	0.14a	0.03a	0.04a	0.18a	0.10a	0.01a	0.01a	0.03a	0.01ab
Furadan 90DB/ WSB	0.5	0.01ab	0.06a	0.31a	0.29a	0.05a	0.14a	0.18a	0.14a	0.00a	0.01a	0.01a	0.00a
Lorsban 4E	0.5	0.00a	0.08a	0.12a	0.13a	0.00a	0.05a	0.15a	0.03a	0.03a	0.05a	0.00a	0.00a
Untreated		0.05b	0.28b	0.86b	0.28a	0.18b	0.10a	0.31a	0.19a	0.01a	0.03a	0.10b	0.04b

[1]Means in the same column followed by the same letter are not significantly different (p=0.05, DMRT).
[2]Original data were transformed by square root of (y+0.5) before ANOVA.

Table 2B. The effect of Furadan and Lorsban on selected predators and parasites in alfalfa.

Treatment	lb (AI)/ acre	Mean no./sweep on days following treatment[1] Nabids 3	6	9	13	Minute pirate bugs 3	6	9	13	Parasitic Hymenoptera 3	6	9	13
Furadan 4F	0.5	0.08a	0.19b	0.33a	0.26ab	0.58a	3.51a	5.83a	5.13a	0.43a	0.38a	2.16a	1.76a
Furadan 90DB/ WSB	0.5	0.10a	0.15b	0.48a	0.24a	0.88a	3.13a	6.56a	4.93a	0.54a	0.45a	2.01a	2.11a
Lorsban 4E	0.5	0.13ab	0.08a	0.45a	0.23a	1.08a	3.83a	7.28a	4.32a	0.35a	0.25a	1.58a	1.33a
Untreated		0.29b	0.29c	1.03b	0.55b	1.18a	4.15a	6.75a	4.10a	0.96b	0.43a	2.06a	2.71a

[1]Means in the same column followed by the same letter are not significantly different (p=0.05, DMRT).

BLACK CUTWORM INSECTICIDE EVALUATIONS - SPRING AND FALL BARRIER STUDIES

Principal Investigators: Karl Kinney, Eli Levine, Don Kuhlman, and Doyle Dazey

Location: University of Illinois Horticulture Farm, Urbana, Illinois

Objectives: The objectives of our spring and fall cutworm barrier studies were to evaluate registered and non-registered cutworm insecticides in side-by-side field comparisons, to provide information about different methods of application of cutworm control products, and to identify those procedures that will allow us to generate useful and practical data from cutworm barrier studies in the future.

INTRODUCTION

Four cutworm control options are currently available to producers in Illinois: (1) pre-plant incorporated treatments (PPI), (2) planting time treatments, (3) pre-emergence treatments (PRE), and (4) rescue treatments. The occurrence of economically damaging populations in any given year is difficult to predict with any certainty. As a consequence, farmers must select their management strategy based on what they believe is the "best choice" for their situation. Regardless of which control strategy a producer selects, many factors can affect the performance of a product after it is applied. Data from research trials can provide useful information about the performance of products under various conditions, and this, in turn, enables farmers, industry representatives, and university personnel to better understand the complex processes at work in natural field situations.

In the spring and fall of 1986, investigators from the University of Illinois and the Illinois Natural History Survey established black cutworm barrier trials to evaluate the performance of registered and non-registered cutworm control products. In all, four studies were conducted, two in the spring and two in the fall. The first study in the spring was established to evaluate PPI and PRE treatments (Tables 3A and 3B), and rescue treatments were evaluated in the second study (Tables 4A and 4B). Both of the fall studies involved the evaluation of liquid and granular planting time and PRE treatments (Tables 5A, 5B, 6A, and 6B). A seed treatment was also included in one study (Tables 6A and 6B). All studies were similar in experimental design and plot lay-out but differed in the number of cutworms introduced into the barriers and the timing of these infestations.

If cutowrms are to be a problem in any given field, eggs and/or larvae are usually already present when a grower plants corn. In some cases, however, eggs laid as late as 2 weeks after planting time can produce larvae that will damage the corn (Troester et al. 1982). In our barrier trials, 3rd to 5th instar cutworm larvae were introduced into the barriers when corn plants had reached the first true-leaf stage of development (V1) (Ritchie and Hanway 1982). Cutworms introduced at this time are representative of the age group (eggs and/or larvae) that would have been present at planting time. All cutworm larvae used in our studies were reared on corn using the methods described by Levine et al. (1982).

The disadvantage of our method of investigation is that we have no idea what level of control might have been achieved with PPI, planting time, or PRE treatments had the cutworms been present when the treatments were applied. The advantage is that we are evaluating product performance under "worst case" conditions because the cutworms are introduced about 10 to 12 days after planting time. Conversely, when we applied rescue treatments in our barrier studies, we were approaching a more realistic field situation. However, the level of damage within our barriers still may have exceeded the level that might have occurred in a natural situation because the larvae were confined and were provided with a limited number of plants.

Because this was our first hands-on experience with barriers of this size and construction (barrier description and discussion is presented later in the "Methods and Materials" section), we varied the number of larvae introduced and the timing of the introduction in order to give us a better understanding of the thresholds that will provide the most useful data in future studies of this kind. Ultimately, we want to know how these data (barrier studies) can be applied to our understanding of the problems associated with natural field conditions.

METHODS AND MATERIALS

Each plot consisted of 4 rows of corn 50 feet long planted on 30-inch centers (10' x 50' rectangle). A randomized complete block design was used to assign treatments to specific plots. Each treatment was replicated four times except where noted. One cutworm barrier was erected around the middle two rows of each plot near the middle of the 50-foot-long treatment where insecticide applications (tractor speed, pesticide delivery, etc.) were assumed to be the most uniform. The cutworm barriers were constructed of 14-gauge steel and measured 6 feet square with sides that were 5 inches tall. Dirt was packed around the outer edges of each barrier to reduce the possibility of cutworm escape.

All liquid PPI, PRE (except where noted), and rescue treatments were applied with a 10-foot boom mounted to the rear of a John Deere 3020 tractor and powered by a compressed air delivery system. Solutions were broadcast at 40 psi in 10.8 gpa of finished spray with a tractor speed of 4 mph. TeeJet (XR8003) nozzles were placed 20 inches apart on the boom and the boom height was approximately 17-19 inches above the ground during applications. Wind was minimal during applications. PPI treatments were blended to a depth of 1-2 inches in the soil with a spike-tooth harrow or to a depth of 3-4 inches with a disk within one hour after application. PRE treatments were not incorporated.

The plots were planted with a John Deere 7000 series Max-Emerge planter. Granules were applied in a 7-inch band ahead of the firming wheels and incorporated with spring tines (7" band AI) or were applied in furrow and incorporated with spring tines (furrow AI). Bench-calibrated Noble[R] units were attached to each planter unit and were used to deliver the granules at the appropriate rate of application. A TeeJet (8002E) nozzle was mounted behind the planter unit at a height of 7-8 inches above the ground to create a 15-inch band for the PRE treatments. These treatments were not incorporated. PRE treatments were applied in 15 gpa of finished spray with

a ground speed of 5 mph. Seed hoppers were emptied and pre-treated seed was placed in each to plant the plots where the seed treatment would be evaluated.

All spring PPI, PRE, and planting-time insecticide treatments were applied just before or at planting time on 28 May, 1986. Five 4th to 5th instar cutworm larvae were placed within each barrier on 8 June, 1986, at 7:00 pm. An additional five 4th to 5th instar cutworm larvae were placed within each barrier on 9 June, 1986, at 8:30 am. Rescue treatments were applied to the plots on 9 June in the afternoon after cutworms had been allowed to establish.

Approximately 2.7 inches of rain fell on the spring cutworm plots between planting time (28 May) and 8 June when the first cutworms were introduced (Appendix A-1). The rainfall, combined with soils considered to be relatively poor in tilth (2.1% organic matter, Appendix A-9), produced a hardened crust in the upper 1-inch of soil. A rotary hoe was used 5 days after planting to break the crusty soil and to aid plant emergence.

In order to apply the rescue treatments, we removed the barriers immediately prior to treatment and then replaced them as soon as possible after treatment. A few cutworms were killed by the tractor tires, but this effect was assumed to be similar in all plots because all were treated in the same manner. No cutworms were observed exiting the previously confined areas during the short period of time the barriers were removed. In addition, the rescue treatments were applied during the day when cutworms typically remain inactive under the soil. As a result, the effect that short-term removal of barriers had on the rescue treatment comparisons was considered to be negligible.

In the fall, planting-time and PRE treatments were applied, as previously described, during planting on 29 August, 1986. Five 3rd to 5th instar cutworm larvae were placed in each barrier on 9 September, 1986, at 7:00 pm. In one of the fall studies (Tables 6A and 6B), an additional three 3rd to 5th instar cutworm larvae were introduced on 12 September, 1986, at 7:00 pm.

RESULTS AND DISCUSSION

A summary of the agronomic and experimental factors for this year's cutworm barrier studies is presented in Table 7, and information regarding the soil analyses for the cutworm plots is presented in Appendix A-9. Raw data for each study are summarized in Tables 3A, 4A, 5A, and 6A; summaries for each study are presented in Tables 3B, 4B, 5B, and 6B.

Spring Studies

<u>Insecticides applied PPI and PRE</u>. Many PRE and PPI treatments provided inconsistent cutworm control when compared to the levels of damage recorded in the untreated check (Tables 3A and 3B). Although several products seemed to provide some level of control, the results were not statistically significant, and further, there were no apparent trends in the data with respect to either product performance or application method. It is

difficult to determine what effect, if any, the rainfall and soil conditions may have had on the performance of products in this study.

Harris and Turnbull (1978) suggested that pyrethroid insecticides may become inactive when incorporated deeply into the soil. Other research by Levine and Felsot (1986) indicates that there may be some level of activity when the pyrethroids are only lightly incorporated into the top 1-inch of soil. Unfortunately, the data we generated in our studies are too ambiguous for us to support or deny these previous findings. However, we will continue to evaluate the performance of PPI and PRE applications of pyrethroid insecticides in our trials because corn producers in Illinois are using these methods and we do not want to discount their potential effectiveness after only one year's results have been examined.

Rescue treatments. All products evaluated as rescue treatments provided consistent control when compared to the level of damage recorded in the untreated check in this year's barrier studies (Tables 4A and 4B). Lorsban, Pounce, Ambush, and Baythroid eliminated cutting activity within 2 days after treatment. Although cutting was recorded 4 and 10 days after treatment with CGA 12223 4E and Asana 1.9 EC, respectively, these products still significantly reduced the mean number of plants cut when compared to the untreated check (Table 4B).

Fall Studies

Only about 0.04 inch of rain fell between planting time (29 August) and the first cutworm introductions on 9 September during the fall studies. During the 2-week period after 9 September, an additional 3.25 inches of rain fell on the plots (Appendix A-2). Despite this additional rainfall, soil-crusting was much less severe in the fall studies than in the spring studies. Cutworm activity was recorded in some of the plots up to 16 days following the introduction of the cutworms into the barriers (Table 5B). Based on this, the effect that rainfall and soil conditions had on cutworm activity during the fall studies was considered negligible. Because moisture activates granular formulations, the abundance of moisture may have aided the performance of some of the granular soil insecticides.

Planting-time granules. The mean numbers of plants cut in plots treated with PP-993 1.5G, Aastar 15G, and Pounce 1.5G were significantly lower than the mean number of plants cut in the untreated check (Table 5B). The mean numbers of plants cut in plots treated with SC-0567 10G, Baythroid 0.375G, Pydrin 0.5G, Dyfonate, Counter 15G, Furadan 15G, and Lorsban 15G were not significantly different from the mean number of plants cut in the untreated check (Table 5B). PP-993 was the most consistent product in the fall trials with respect to cumulative plants cut, percentage of plants cut, and last recorded cutting activity. Although the PRE and PPI treatments produced variable results in the spring studies, both Asana 1.9 EC and Dyfonate 4.6 MS, when applied as 15-inch PRE bands in the fall studies, reduced cutting significantly when compared with the level of damage in the untreated check (Table 5B).

Planting-time granules and insecticides applied PRE. In the second fall study (Tables 6A and 6B), there were no statistically significant differences among treatment means (including the untreated check), although

trends toward some level of control were apparent for some products (CGA 12223, Lorsban, and Pounce). It is worth noting that as many as four or five out of a total of eight cutworms introduced into the barriers in this study were 3rd instar larvae. This represents a larger percentage of 3rd instars (approximately 50 percent) used to infest these barriers when compared with about one in five (approximately 20 percent) for the other three barrier studies. This may account for some of the variability in the results in the second fall study.

CONCLUSIONS

The rescue treatments seemed to provide more consistent cutworm control in our barrier studies than did most of the PRE, PPI, and planting time treatments when compared to the untreated checks. There were exceptions to this. For example, PP-993 1.5G, Aastar 15G, and Pounce 1.5G all provided reasonably consistent control when compared to the untreated checks, as did Asana 1.9EC and Dyfonate 4.6MS when applied as PRE treatments in a band.

Based on the data from this year's barrier studies, we feel there is not enough information to pass judgement on the PRE, PPI, and planting-time treatments at this time. There was a considerable amount of variability with regard to product performance and there were indications that some of these products and application methods were better than the untreated checks. Consequently, it seems most appropriate to generate more data in the future to try to resolve these questions.

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Table 3A. Black cutworm insecticide evaluations, spring barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Method of application[4]	Mean number of plants cut days post-treatment[1,2]					
			12	14	16	19	22	26
Asana 1.9EC	0.025	PRE	0.00	2.00	2.75	3.00	3.00	3.25
Pydrin 2.4EC	0.1	PRE	0.00	3.00	3.00	3.25	3.25	3.50
Pounce 3.2EC	0.15	PPI 4"	0.25	3.50	3.50	3.50	3.50	3.50
Lorsban 4E	1.0	PPI 4"	0.25	2.75	3.00	3.25	3.75	3.75
Baythroid 2EC	0.025	PRE	0.00	2.00	2.50	3.00	4.00	4.00
Baythroid 2EC	0.025	PPI 4"	0.00	3.00	3.25	4.00	4.00	4.00
Pounce 3.2EC	0.2	PPI 2"	0.00	3.75	4.00	4.00	4.50	4.50
Pydrin 2.4EC	0.1	PPI 2"	0.25	3.25	4.00	4.25	4.50	4.50
Check	...	...	0.38	3.63	4.00	4.38	4.50	4.50
Lorsban 15G	1.0	7" band	0.75	4.00	4.75	4.75	4.75	4.75
Ambush 2E	0.1	PPI 4"	0.25	4.75	5.00	5.00	5.00	5.00
Lorsban 4E	1.0	PPI 2"	0.50	3.25	3.75	4.25	5.25	5.25
Pounce 3.2EC	0.1	PPI 2"	1.00	4.00	4.75	5.00	5.25	5.25
Ambush 2E	0.1	PRE	0.25	4.25	4.50	5.25	5.25	5.25
Pounce 3.2EC	0.2	PPI 4"	0.50	4.50	5.00	5.25	5.50	5.50
Asana 1.9EC	0.0375	PRE	0.25	2.75	3.50	4.50	5.50	5.75
Baythroid 2EC	0.025	PPI 2"	0.50	3.25	4.50	5.00	5.50	6.00
Ambush 2E	0.1	PPI 2"	0.75	4.25	5.00	6.25	6.25	6.25
Pounce 3.2EC	0.1	PRE	0.00	4.25	4.75	5.50	6.00	6.50
Pounce 3.2EC	0.1	PPI 4"	0.25	6.00	6.33	6.33	6.33	6.67
Pounce 3.2EC	0.15	PPI 2"	0.50	4.50	5.00	6.25	6.25	6.75
Lorsban 4E	0.75	PPI 2"	0.75	5.50	5.75	6.50	6.75	7.00
Lorsban 4E	1.5	PPI 4"	0.50	5.75	7.00	7.50	7.75	7.75

[1] Each mean was calculated from the cumulative total of plants cut per barrier on the corresponding "days post-treatment."

[2] Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 17 plants/barrier) 11 days post-treatment, and an additional five 3rd to 5th instar black cutworm larvae were introduced 12 days post-treatment.

[3] Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

[4] Pre-emergence treatments (PRE) were broadcast on the soil surface and not incorporated; pre-plant incorporated treatments (PPI) were incorporated in the soil to a 2-inch depth with a harrow or to a 4-inch depth with a disk.

Table 3B. Black cutworm insecticide evaluations, spring barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Method of application[4]	Mean number plants cut[1,2] N[5]	mean	SD	Mean percentage plants cut	Last day of cutting activity post-infestation/ post-treatment
Asana 1.9EC	0.025	PRE	4	3.25	2.63	18.0	15 / 26
Pydrin 2.4EC	0.1	PRE	4	3.50	1.91	21.0	15 / 26
Pounce 3.2EC	0.15	PPI 4"	4	3.50	1.73	22.0	3 / 14
Lorsban 4E	1.0	PPI 4"	4	3.75	2.06	20.0	11 / 22
Baythroid 2EC	0.025	PRE	4	4.00	0.82	22.0	11 / 22
Baythroid 2EC	0.025	PPI 4"	4	4.00	2.45	23.0	8 / 19
Pounce 3.2EC	0.2	PPI 2"	4	4.50	4.04	27.0	11 / 22
Pydrin 2.4EC	0.1	PPI 2"	4	4.50	1.29	24.0	11 / 22
Check	...	...	8	4.50	2.07	26.0	11 / 22
Lorsban 15G	1.0	7" band	4	4.75	1.26	27.0	5 / 16
Ambush 2E	0.1	PPI 4"	4	5.00	0.82	29.0	3 / 14
Lorsban 4E	1.0	PPI 2"	4	5.25	2.63	26.0	11 / 22
Pounce 3.2EC	0.1	PPI 2"	4	5.25	2.99	28.0	11 / 22
Ambush 2E	0.1	PRE	4	5.25	2.06	29.0	8 / 19
Pounce 3.2EC	0.2	PPI 4"	4	5.50	2.08	32.0	11 / 22
Asana 1.9EC	0.0375	PRE	4	5.75	3.77	32.0	15 / 26
Baythroid 2EC	0.025	PPI 2"	4	6.00	1.41	35.0	15 / 26
Ambush 2E	0.1	PPI 2"	4	6.25	1.89	35.0	8 / 19
Pounce 3.2EC	0.1	PRE	4	6.50	1.29	38.0	15 / 26
Pounce 3.2EC	0.1	PPI 4"	4	6.67	2.52	42.0	15 / 26
Pounce 3.2EC	0.15	PPI 2"	4	6.75	3.59	43.0	15 / 26
Lorsban 4E	0.75	PPI 2"	4	7.00	3.27	40.0	15 / 26
Lorsban 4E	1.5	PPI 4"	4	7.75	1.26	42.0	11 / 22

[1] Critical F-value for treatments was not significant for values included under the mean column. Mean values are presented with the standard deviation (SD).

[2] Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 17 plants/barrier) 11 days post-treatment, and an additional five 3rd to 5th instar black cutworm larvae were introduced 12 days post-treatment.

[3] Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

[4] Pre-emergence treatments (PRE) were broadcast on the soil surface and not incorporated; pre-plant incorporated treatments (PPI) were incorporated in the soil to a 2-inch depth with a harrow or to a 4-inch depth with a disk.

[5] N = number of replications.

Table 4A. Black cutworm insecticide evaluations, spring barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Rescue treatment	Rate lb ai/ acre[3]	Method of application	Mean number of plants cut days post-treatment[1,2]				
			2	4	7	10	14
Lorsban 4E	1.0	Broadcast	1.00	1.00	1.00	1.00	1.00
Pounce 3.2EC	0.1	Broadcast	1.25	1.25	1.25	1.25	1.25
CGA 12223 4E	1.0	Broadcast	1.25	1.50	1.50	1.50	1.50
CGA 12223 4E	0.66	Broadcast	1.50	1.50	1.50	1.50	1.50
Ambush 2E	0.1	Broadcast	1.50	1.50	1.50	1.50	1.50
Asana 1.9EC	0.025	Broadcast	1.50	1.75	1.75	2.00	2.00
Baythroid 2EC	0.025	Broadcast	2.50	2.50	2.50	2.50	2.50
Check	...	...	3.25	3.63	4.00	4.13	4.13

[1] Each mean was calculated from the cumulative total of plants cut per barrier on the corresponding "days post-treatment."

[2] Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 17 plants/barrier) 2 days prior to treatment, and, an additional five 3rd to 5th instar black cutworm larvae were introduced one day prior to treatment.

[3] Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

Table 4B. Black cutworm insecticide evaluations, spring barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Method of application	Mean number plants cut[1,2] N[4]	Mean number plants cut[1,2] mean	Mean percentage plants cut	Last day of cutting activity post-infestation/ post-treatment
Lorsban 4E	1.0	Broadcast	4	1.00 a	6.0	3 / 2
Pounce 3.2EC	0.1	Broadcast	4	1.25 a	8.0	3 / 2
CGA 12223 4E	1.0	Broadcast	4	1.50 a	9.0	5 / 4
CGA 12223 4E	0.66	Broadcast	4	1.50 a	9.0	3 / 2
Ambush 2E	0.1	Broadcast	4	1.50 a	9.0	3 / 2
Asana 1.9EC	0.025	Broadcast	4	2.00 a	13.0	11 / 10
Baythroid 2EC	0.025	Broadcast	4	2.50 a	16.0	3 / 2
Check	...	...	8	4.13 b	24.5	11 / 10

[1] Means in a column followed by the same letter are not significantly different (p = 0.1; DMRT). Mean value represents cumulative total plants cut per barrier.

[2] Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 17 plants/barrier) 2 days prior to treatment, and, an additional five 3rd to 5th instar black cutworm larvae were introduced one day prior to treatment.

[3] Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

[4] N = number of replications.

Table 5A. Black cutworm insecticide evaluations, fall barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Application method[4,5]	Mean number of plants cut days post-treatment[1,2]									
			12	13	14	15	16	17	18	20	24	27
PP 993 1.5G	0.1	7" band AI	0.75	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
PP 993 1.5G	0.075	7" band AI	0.25	0.75	1.00	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Aastar 15G	1.0	7" band AI	0.25	0.50	0.75	0.75	0.75	0.75	1.00	1.25	1.25	1.50
Asana 1.9EC	0.025	15" band PRE	0.50	1.25	1.50	1.50	1.50	1.50	1.50	1.75	1.75	1.75
Dyfonate 4.6MS	1.0	15" band PRE	0.25	0.75	1.25	1.25	1.50	1.50	1.75	1.75	1.75	1.75
Asana 1.9EC	0.0125	15" band PRE	0.75	1.25	1.25	1.25	1.25	1.25	1.25	1.50	1.50	1.75
Pounce 1.5G	0.1	7" band AI	0.00	1.00	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75
SC 0567 10G	1.0	7" band AI	0.25	0.75	1.00	1.25	1.25	1.75	1.75	1.75	2.00	2.00
Baythroid .375G	0.02	7" band AI	0.00	1.25	1.25	1.75	1.75	1.75	1.75	2.00	2.00	2.00
Pydrin .5G	0.1	7" band AI	0.50	1.25	1.75	1.75	2.00	2.25	2.25	2.25	2.25	2.25
Dyfonate (clay)	1.0	7" band AI	0.67	1.67	2.00	2.00	2.00	2.00	2.33	2.67	2.67	2.67
SC 0567 10G	0.5	7" band AI	0.50	1.25	1.00	1.75	1.75	2.00	2.25	2.25	2.75	2.75
Counter 15G	1.0	furrow AI	0.25	1.00	1.50	1.50	1.50	1.50	1.50	2.50	2.75	2.75
Furadan 15G	1.0	7" band AI	0.50	1.00	1.25	1.50	1.50	1.50	1.75	2.25	2.50	2.75
Lorsban 15G	1.0	7" band AI	1.00	2.50	2.75	2.75	3.00	3.00	3.00	3.00	3.00	3.00
Check	...	...	0.67	1.79	1.96	2.13	2.29	2.63	3.13	3.50	3.79	3.92
Dyfonate 20G	1.0	7" band AI	0.67	1.33	3.33	3.33	3.67	4.00	4.00	4.00	4.33	4.33

1 Each mean was calculated from the cumulative total of plants cut per barrier on the corresponding "days post-treatment."

2 Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 12 plants/barrier) 11 days post-treatment.

3 Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

4 Liquid and granule rates delivered in 15-inch and 7-inch bands, respectively, or in furrow (granules).

5 Granular treatments were applied ahead of firming wheels (AI) or in furrow (furrow AI) and incorporated with spring tines; liquid bands were applied as pre-emergence treatments (PRE) with no incorporation.

Table 5B. Black cutworm insecticide evaluations, fall barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Application method[4,5]	Mean number plants cut[1,2] N[6]	Mean number plants cut[1,2] mean	Mean percentage plants cut	Last day of cutting activity post-infestation/ post-treatment
PP 993 1.5G	0.1	7" band AI	4	1.00 a	7.0	3 / 14
PP 993 1.5G	0.075	7" band AI	4	1.25 a	10.0	4 / 15
Aastar 15G	1.0	7" band AI	4	1.50 a	13.0	16 / 27
Asana 1.9EC	0.025	15" band PRE	4	1.75 a	13.0	9 / 20
Dyfonate 4.6MS	1.0	15" band PRE	4	1.75 a	14.0	7 / 18
Asana 1.9EC	0.0125	15" band PRE	4	1.75 a	14.0	16 / 27
Pounce 1.5G	0.1	7" band AI	4	1.75 a	12.0	3 / 14
SC 0567 10G	1.0	7" band AI	4	2.00 ab	15.0	13 / 24
Baythroid .375G	0.02	7" band AI	4	2.00 ab	15.0	9 / 20
Pydrin .5G	0.1	7" band AI	4	2.25 a-c	16.0	6 / 17
Dyfonate (clay)	1.0	7" band AI	3	2.67 a-c	21.0	9 / 20
SC 0567 10G	0.5	7" band AI	4	2.75 a-c	25.0	13 / 24
Counter 15G	1.0	furrow AI	4	2.75 a-c	21.0	13 / 24
Furadan 15G	1.0	7" band AI	4	2.75 a-c	28.0	16 / 27
Lorsban 15G	1.0	7" band AI	4	3.00 a-c	26.0	5 / 16
Check	...	...	7	3.92 bc	30.5	16 / 27
Dyfonate 20G	1.0	7" band AI	3	4.33 c	34.0	13 / 24

1 Means in a column followed by the same letter are not significantly different (p = 0.1; DMRT). Each mean was calculated from the cumulative total of plants cut per barrier.

2 Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 12 plants/barrier) 11 days post-treatment.

3 Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

4 Liquid and granule rates delivered in 15-inch and 7-inch bands, respectively, or in furrow (granules).

5 Granular treatments were applied ahead of firming wheels (AI) or in furrow (furrow AI) and incorporated with spring tines; liquid bands were applied as pre-emergence treatments (PRE) with no incorporation.

6 N = number of replications.

Table 6A. Black cutworm insecticide evaluations, fall barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Application method[4,5]	Mean number of plants cut days post-treatment[1,2] 12	13	14	15	16	17	18	20	24	27
CGA 12223 10G	0.5	7" band AI	0.00	0.00	0.00	0.00	0.25	0.50	1.00	1.25	1.25	1.25
Lorsban 15G	1.0	7" band AI	0.00	0.25	0.25	0.50	1.00	1.25	1.25	1.25	1.25	1.25
Pounce 3.2EC	0.1	15" band PRE	0.50	1.00	1.25	1.25	1.25	1.50	1.50	1.50	1.75	2.00
Pounce 3.2EC	0.05	15" band PRE	0.00	0.75	1.00	1.00	1.50	1.50	1.50	1.75	1.75	2.00
Magnum 90	16 oz/cwt	seed trt.	0.00	0.25	0.75	1.50	1.75	2.00	2.00	2.00	2.25	2.25
Check	...	...	0.08	0.58	1.00	1.33	1.75	1.92	2.08	2.25	2.25	2.25
CGA 12223 20G	1.0	7" band AI	0.25	0.50	1.25	1.25	1.75	2.25	2.50	2.50	2.50	2.50
Ambush 2E	0.05	15" band PRE	0.25	0.75	1.25	1.75	2.00	2.00	2.50	2.75	3.00	3.25

1 Each mean was calculated from the cumulative total of plants cut per barrier on the corresponding "days post-treatment."

2 Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 13 plants/barrier) 11 days post-treatment and three additional 3rd to 5th instar black cutworm larvae were introduced 14 days post-treatment.

3 Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

4 Liquid and granule rates delivered in 15-inch and 7-inch bands, respectively.

5 Granular treatments were applied ahead of firming wheels and incorporated with spring tines (AI); liquid bands were applied as pre-emergence treatments (PRE) with no incorporation.

Table 6B. Black cutworm insecticide evaluations, fall barrier trials, Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

Treatment	Rate lb ai/ acre[3]	Application Method[4,5]	Mean number plants cut[1,2] N[6]	mean	SD	Mean percentage plants cut
CGA 12223 10G	0.5	7" band AI	4	1.25	0.96	9.0
Lorsban 15G	1.0	7" band AI	4	1.25	0.50	10.0
Pounce 3.2EC	0.1	15" band PRE	4	2.00	1.41	14.0
Pounce 3.2EC	0.05	15" band PRE	4	2.00	1.83	15.0
Magnum 90	16 oz/cwt	seed trt.	4	2.25	2.06	17.0
Check	...	...	12	2.25	1.71	17.7
CGA 12223 20G	1.0	7" band AI	4	2.50	2.08	19.0
Ambush 2E	0.05	15" band PRE	4	3.25	3.59	25.0

1 Critical F-value for treatments was not significant for values included under the mean column. Mean values are presented with the standard deviation (SD).

2 Five 3rd to 5th instar black cutworm larvae were introduced into 6-feet square barriers covering two 30-inch center rows of corn (approximately 13 plants/barrier) 11 days post-treatment and three additional 3rd to 5th instar black cutworm larvae were introduced 14 days post-treatment.

3 Rate of active ingredient per acre (ai/A) based on 40-inch row spacing.

4 Liquid and granule rates delivered in 15-inch and 7-inch bands, respectively.

5 Granular treatments were applied ahead of firming wheels and incorporated with spring tines (AI); liquid bands were applied as pre-emergence treatments (PRE) with no incorporation.

6 N = number of replications.

Table 7. Summary of agronomic and experimental factors for the spring and fall black cutworm studies, University of Illinois Horticulture Vegetable Crops Farm, Urbana, Champaign County, Illinois, 1986.

	Spring Studies		Fall Studies	
	Tables 3A,3B	Tables 4A,4B	Tables 5A,5B	Tables 6A,6B
Agronomic				
Planting Date	28 May	28 May	29 August	29 August
Hybrid	Noble Bear #2401	Noble Bear #2401	Noble Bear #2401	Noble Bear #2401
Population	26,100	26,100	26,100	26,100
Rows	30"	30"	30"	30"
Herbicides	Lasso 1.5 qt. Bladex 2 qt.	Lasso 1.5 qt. Bladex 2 qt.	none ...	none ...
Tillage	Fall chisel	Fall chisel	Fall chisel	Fall chisel
Fertilizer				
Starter	none	none	none	none
Experimental				
Mean number plants per barrier	17.6	16.4	13.4	13.4
Cutworm threshold per barrier	10	10	5	8
Number of infestations	2	2	1	2
Infestation date	8/9 June	8/9 June	9 Sept.	9/12 Sept.
Plots				
Number of rows	4	4	4	4
length	50'	50'	50'	50'
replications	4	4	4	4

(continued)

Table 7 (contd).

	Spring Studies		Fall Studies	
	Tables 3A,3B	Tables 4A,4B	Tables 5A,5B	Tables 6A,6B
Treatments				
Method of application	PPI, PRE and at planting	Rescue ...	PRE and at planting	PRE, at planting, and seed trt.
Liquids	Broadcast	Broadcast	15" band	15" band
boom height	17-19"	17-19"	7-8"	7-8"
nozzle type	TeeJet XR8003	XR8003	TeeJet 8002E	8002E
pressure	40 psi	40 psi	40 psi	40 psi
ground speed	4 mph	4 mph	5 mph	5 mph
Granules	7" band AI	...	7" band AI	7" band AI
incorporation	spring tine	...	spring tine	spring tine
ground speed	5 mph	...	5 mph	5 mph

COMMON STALK BORER INSECTICIDE EVALUATION

Principal Investigators: Kevin Steffey, Ann Carrick, Karl Kinney, and Doyle Dazey

Location and Cooperators: Swalve Farms, Forreston, Ogle County, Illinois, Lowell Swalve, owner
Stan Eden, Ogle Co. Extension Adviser, Oregon, Illinois

Objective: The objective of this study was to evaluate the effectiveness of Pounce 1.5G, Pounce 3.2EC, and Capture 2EC for control of the common stalk borer, Papaipema nebris (Guenee), in field corn.

INTRODUCTION

The common stalk borer (CSB) is one of a number of insect pests that have become more prevalent in no-till and reduced tillage situations in Illinois (Kuhlman 1982). With more producers switching to these types of tillage practices, the common stalk borer is likely to remain a potential problem. However, current estimates indicate that less than 1 percent of the corn in Illinois is treated annually for this pest (Kinney 1986, Colwell 1985).

Female moths lay eggs in late summer, and they prefer grasses along fence rows, in contour strips, in water-ways, or in weedy fields as oviposition sites (Levine et al. 1982). Larvae emerge over several weeks in the spring and can cause significant damage to newly emerged corn plants. The CSB causes damage to corn by entering the plant at the base and tunneling upward or by boring into the whorl and feeding downward. Their feeding activity can stunt plants, reduce plant vigor, or can cause the death of the plant, thus causing yield losses (Levine 1982).

During May of 1986, investigators from the University of Illinois and the Illinois Natural History Survey established an insecticide trial in a field with a history of CSB problems. Insecticide treatments were applied to the 4 rows of corn nearest the fence row, and damage reduction data were recorded on three separate dates following treatment.

METHODS

A cornfield located on the Lowell Swalve Farm near Forreston, Illinois, was selected for this study initially because recurrent problems with CSB had been reported along field margins. Mr. Swalve planted the corn on 30 April, 1986, on 36-inch centers and applied Counter 15G in furrow (1 lb. ai/A) at planting time for corn rootworm control. Common stalk borer larval feeding was first observed in the corn row nearest the fence row on 23 May, 1986, when most of the corn was in the 2-leaf stage of development (V2) (Ritchie and Hanway 1982).

The most common weed species present in the fence row were (in order of frequency): field horsetail (Equisetum arvense), quackgrass (Agropyron repens), cheat (Bromus secalinus), common milkweed (Asclepias syriaca), horseweed (Conyza canadensis), western salsify (Tragopogon dubius), and multiflora rose (Rosa multiflora). Many of these weeds probably served as oviposition sites during late summer in 1985 when females laid eggs in this fence row.

A 1/4-mile stretch of corn bordering the fence row was divided into 16 equally sized plots. Each plot was 50 feet long by 4 rows wide. A randomized complete block design with 4 replications was used to assign treatments to specific plots.

Insecticide treatments were applied on 23 May, 1986, between 7:00 and 8:00 pm. Winds were from the east at approximately 5-8 mph. The wind was strong enough to prevent insecticide delivery to the windward row of corn (row 4, the row farthest from the fence row). As a consequence, no data were gathered from this row during the study.

Liquid treatments were broadcast from a 10-foot boom mounted on the rear of a John Deere 3020 tractor. A compressed air application system was calibrated to deliver 11 gpa of finished spray at 40 psi at a ground speed of 4 mph. TeeJet (XR8003) nozzles were spaced at 20-inch intervals on the boom and the boom height during application was about 17-19 inches above the ground. Pounce 1.5G was distributed from a calibrated Noble unit mounted on a bicycle-wheeled applicator and was applied over each row in a 7-10 inch band.

On the date that the treatments were applied, CSB damage was noticeable in the corn row nearest the fence row (row 1), but we failed to take pre-treatment damage estimates. No damage was evident in the other three rows of the plots (rows 2, 3, and 4).

Damage estimates were recorded on 30 May, 8 June, and 13 June (7, 16, and 21 days post-treatment, respectively). A 14.5-foot sample (1/1000 acre for 36-inch centers) in each of the first three rows in each plot was evaluated. The total number of plants and the total number of damaged plants were recorded for each sample. The corn was mostly in the 3-leaf stage (V3) on 30 May, the 6-leaf stage (V6) with collar regions visible on 8 June, and the 6-7 leaf stage (V6,V7) with visible collars on 13 June.

RESULTS AND DISCUSSION

The corn closest to the fence row (row 1) was the most heavily damaged. About 61 percent of the plants in the untreated check plots had been damaged by the last sampling date on 13 June (Table 8). Corn plants in rows 2 and 3 were also damaged as larvae moved into the field. Approximately 34 percent and 9 percent of the plants in the untreated check plots had been damaged in rows 2 and 3, respectively, through 13 June (Table 8).

Most of the insecticide treatments were generally ineffective in controlling the CSB. The percentage of plants damaged in the plots treated with Pounce 3.2EC was numerically but not statistically less than the

percentage of plants damaged in the untreated check on the first sampling date (7 days post-treatment, Table 8). However, the percentage of plants damaged in the plots treated with Pounce 3.2EC increased considerably by the second and third sampling dates (16 and 21 days post-treatment, Table 8), and the mean percentage of plants damaged for the duration of the experiment was not significantly different from the mean percentage of plants damaged in the untreated check (Table 9).

Capture 2EC was ineffective in controlling the CSB on all sampling dates. The mean percentage of plants damaged was not statistically different from the mean percentage of plants damaged in the untreated check (Tables 8 and 9).

The percentage of plants damaged in the plots treated with Pounce 1.5G was numerically but not statistically less than the percentage of plants damaged in the untreated check on all sampling dates (Tables 8 and 9). This product reduced damage to the first 3 rows of corn by nearly 12 percent when compared to both the untreated check plots and to the plots treated with Pounce 3.2EC (Table 9).

One final point worth noting is that on one occasion a hop vine borer (HVB), Hydraecia immanis Guenee, was recovered from a plant during post-treatment sampling. These insects were certainly present and probably caused some of the damage in our plots, but the CSB was responsible for the majority of the damage. However, in northwestern Illinois, both of these insects can become potential problems under circumstances similar to this study.

CONCLUSIONS

The insecticides evaluated in our trial did not provide acceptable control of the CSB. Whether the timing of our applications or placement of the insecticides was responsible for our failure to control CSB cannot be determined from our data. The CSB, like other insects that tunnel into corn, is nearly impossible to control once it enters the plant.

"Rescue" treatments for control of CSB have been effective in several trials conducted by other entomologists in the Midwest, while these same rescue treatments have proved to be ineffective in other situations. Our data simply point out the complexity of achieving good control of the CSB. This insect warrants further study so that corn growers may eventually have effective control tools to prevent serious damage.

LITERATURE CITED

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Table 8. Common stalk borer insecticide evaluation, Ogle County, Illinois, 1986.

7 Days Post-treatment

Product	Rate[2]	Method of application	Mean % plants damaged per 1/1,000 acre[1] Row 1	Row 2	Row 3
Capture 2EC	0.04	broadcast	27.3	5.3	5.2
Pounce 3.2EC	0.1	broadcast	8.0	2.2	0.0
Pounce 1.5G	0.1	7"-band over row	11.8	3.2	1.1
Check	...	...	18.7	6.8	0.0

16 Days Post-treatment

Product	Rate	Method of application	Mean % plants damaged per 1/1,000 acre Row 1	Row 2	Row 3
Capture 2EC	0.04	broadcast	62.3	20.0	16.9
Pounce 3.2EC	0.1	broadcast	46.7	28.3	5.1
Pounce 1.5G	0.1	7"-band over row	32.9	4.3	4.2
Check	...	...	50.7	21.6	3.8

21 Days Post-treatment

Product	Rate	Method of application	Mean % plants damaged per 1/1,000 acre Row 1	Row 2	Row 3
Capture 2EC	0.04	broadcast	81.8	35.8	24.7
Pounce 3.2EC	0.1	broadcast	62.7	28.3	12.8
Pounce 1.5G	0.1	7"-band over row	50.6	9.7	8.4
Check	...	...	61.3	34.1	8.8

[1] Mean percentage of plants damaged per 1/1,000 acre calculated by dividing the mean number of plants damaged in the sample by the mean total number of plants in the sample.

[2] Rate expressed as pounds of active ingredient per acre (lb. ai/A).

Table 9. Final data summary for the common stalk borer insecticide evaluation, Ogle County, Illinois, 1986.

Product	Rate[2]	Method	Mean no. plants damaged, all rows days post-treatment[1] 7 days	16 days	21 days	Mean % damage
Capture 2EC	0.04	b-cast	2.50 a[2]	6.67 b	9.50 b	48.2 b
Pounce 3.2 EC	0.1	b-cast	0.67 a	4.67 ab	6.92 a	35.0 ab
Pounce 1.5G	0.1	7" B	1.12 a	3.00 a	5.00 a	23.0 a
Check	...	...	1.67 ab	5.00 ab	6.92 a	34.8 ab

[1] Means in a column followed by the same letter are not significantly different (DMRT, p=0.1).

[2] Rate expressed as pounds of active ingredient per acre (lb. ai/A).

CORN ROOTWORM LARVAL CONTROL WITH REGISTERED AND EXPERIMENTAL SOIL INSECTICIDES AND WITH BIOLOGICAL ORGANISMS

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Objectives: The objectives of these studies were to evaluate registered and experimental chemical soil insecticides in side-by-side field comparisons for control of corn rootworm larvae; to evaluate two biological organisms - *Steinernema feltiae*, an entomogenous nematode, and *Beauveria bassiana*, a pathogenic fungus - in side-by-side field comparisons for control of corn rootworm larvae; and to evaluate new equipment used for making sub-surface soil applications of biological and chemical products.

INTRODUCTION

Western corn rootworms, *Diabrotica virgifera virgifera* LeConte, and northern corn rootworms, *Diabrotica barberi* Smith and Lawrence, are the most serious insect pests of continuous corn in the midwestern United States. Recent estimates indicate that 4-5 million acres of corn in Illinois are treated annually with a planting-time soil insecticide primarily for control of corn rootworm larvae (Colwell 1985, Kinney 1986, Pike 1986). This situation probably will not change in the immediate future because many growers continue to produce corn following corn and because soil insecticides will continue to be the popular choice among growers for corn rootworm control. Bergman (1987) and Steffey et al. (1987) present a more thorough review of corn rootworm management and control in the midwest.

Investigators at the University of Illinois and the Illinois Natural History Survey, together with a number of cooperators, established soil insecticide studies at several locations in Illinois during the summer of 1986. Four studies (Bloomington, Bolton, Henry, and Monmouth) were established specifically to evaluate registered and experimental chemical soil insecticides in side-by-side comparisons. Sub-surface applications of biological and chemical products were also included in the comparisons at Bloomington. A fifth study at Champaign was conducted to evaluate several formulations of Furadan in side-by-side field comparisons. The final study, also at Champaign was established specifically to evaluate the efficacy of sub-surface applications of two biological organisms, nematodes and fungi, for control of corn rootworm larvae.

All chemical soil insecticide evaluations were conducted in a fashion similar to those conducted by other universities in the corn belt. Great care was taken to insure that products were applied properly and that specific rates were delivered accurately. Root ratings were determined by using the Iowa State damage scale where 1 equals no damage and 6 equals severe damage.

The biological study involved the use of new application techniques to deliver the products below the surface of the soil. As a consequence, there were more variables that might have affected the performance of these products. Nevertheless, great care was taken to insure that these products were delivered as accurately as possible. More specific observations about these products and the application techniques we used are provided in the "Results and Discussion" section. At the request of the companies that supplied us with the biological organisms, specific isolate information is not provided for these products.

This year's research acitivites were the first in an expanded effort to evaluate current and future products for the control of corn rootworm larvae. With a few exceptions, the 1986 soil insecticide evaluations provided some very good product comparisons. The rootworm pressure ranged from severe at Bloomington to light at Bolton and Champaign. The history of insecticide use, specifically at Bloomington and Monmouth, apparently contributed to a lack of performance of some products. This will be discussed in greater detail in the "Results and Discussion" section.

METHODS

Registered and Experimental Chemical Soil Insecticide Studies

Locations at Funks Seeds International in Bloomington (McLean Co.), Voss Farm near Bolton (Stephenson Co.), Villiger Farm near Henry (Marshall Co.), and the University of Illinois NW Agronomy Research Center near Monmouth (Warren Co.), were selected for the registered and experimental soil insecticide evaluations during the summer of 1986. At Bloomington, the trial was established on a site where a corn trap crop had been planted late in 1985. At Bolton, the trial was established in a field that had been planted late for corn silage in 1985 and was not tilled prior to planting in 1986. At Henry and Monmouth, the trials were established in fields in which large numbers of rootworm beetles had been reported during the summer of 1985.

Treatments were applied to single-row plots 100 feet long at each location except Bloomington where rows were 80 feet long. Two treatments, nematodes and the sub-surface application of Lorsban 4E, were applied to two adjacent rows of corn in each replication. Treatments were assigned to the plots using a randomized complete block design with 4 replications. Because of the large number of treatments at all four locations, two untreated checks were also included, except at Bloomington where six untreated checks were included. Corn at each location was planted on 30-inch centers (plant population 26,100/acre) with a 4-row John Deere 7000 series Max-emerge planter.

Granules applied at planting time were placed either in furrow or in a 7-inch band ahead of the firming wheels and incorporated with spring tines mounted behind each planter unit, with the following exceptions: Counter 15G, Furadan 15G, and Lorsban 15G were also applied behind the firming wheels with no incorporation at Bloomington; and the recommended placement for EL-499, Eli Lilly's experimental product, was behind the firming wheels. Noble units were calibrated to deliver the appropriate rate for each product and were fitted into chain driven brackets mounted on each planter unit during application.

Granules applied at cultivation time were delivered with Noble metering units mounted in brackets on the cultivator. These treatments were side-dressed with drop tubes on either side of the row at the base of the plants, and then were covered with soil by the cultivator shovels.

Liquids applied at planting time were delivered in a 7-10 inch band with a banding nozzle (TeeJet 8002E) placed ahead of the firming wheels and were incorporated with spring tines. All liquids, with one exception, were applied with a compressed air system calibrated to deliver 20 gpa of finished spray at 28 psi.

At Bloomington, Lorsban 4E was also placed in a 7-9 inch band 3-4 inches beneath the soil surface with a modified anhydrous knife. A shovel welded to the knife lifted dirt below the soil surface and allowed liquid to be placed in a band through an inverted flooding nozzle (1/16 diameter opening). The system was calibrated to deliver 23 gpa of finished spray at 30 psi. In order to balance the torque on the 4-row planter, two of these sub-surface banding tools were mounted on the tool bar at the front of the planter over the middle 2 rows. For this reason, each Lorsban 4E sub-surface treatment was applied to two adjacent rows.

Liquids applied at cultivation time were delivered at the base of the plants with two nozzles (TeeJet 8002E) mounted on either side of the row. The compressed air system was calibrated to deliver 40 gpa at 30 psi for these applications. The insecticides were incorporated by soil thrown up at the base of the plants by the cultivator shovels.

The plots were planted at Bolton on 8 May, at Monmouth on 9 May, at Henry on 13 May, and at Bloomington on 22 May (Tables 16A and 16B). Cultivation treatments were applied at Monmouth on 10 June, at Henry on 11 June, and at Bloomington on 12 June (Tables 16A and 16B). Stand counts were recorded for each plot by counting the number of plants per 1/1,000 acre (17.4 feet - 30" centers) on 29 May at Bolton, on 30 May at both Henry and Monmouth, and on 19 June at Bloomington. No yield data were recorded for any of the plots.

Root rating evaluations were recorded at each location to quantify corn rootworm larval feeding damage. Five roots were dug from each treatment in each replication, washed, and then rated for rootworm larval damage. Exceptions to this are noted in the "Results and Discussion" section. The root ratings were made on 15 July at Bolton, on 16 July at Monmouth, on 17 July at Henry, and on 18 July at Bloomington. The Iowa State system of rating roots, based on a scale of 1 (no visible damage) to 6 (3 or more nodes of roots destroyed), was used to assess the damage.

The root-rating scale used to quantify rootworm damage follows:

1 - No visible damage or only a few minor feeding scars

2 - A few roots with feeding scars, but none chewed off within 1 1/2 inches of the stalk

3 - Several nodal roots eaten off to within 1 1/2 inches of the stalk but less than the entire node of roots destroyed

4 - One node of roots destroyed or the equivalent

5 - Two nodes of roots destroyed or the equivalent

6 - Three or more nodes of roots destroyed or the equivalent

The Furadan formulation evaluation trial conducted at the University of Illinois South Annex Plots in Champaign was identical in experimental design to the previous descriptions. Counter 15G was included for comparative purposes. This study was planted on 2 June, probably late enough that plants escaped any significant rootworm pressure that may have been present during previous weeks. Stand counts were made, as previously described, on 26 June. Root ratings were also recorded, using the methods previously described, on 23 July.

Biological Control Evaluations

A biological control trial was established at the University of Illinois South Annex in Champaign on 21 May, and one planting-time and one cultivation-time rate of nematodes were included in the previously described trial at Bloomington. All biological treatments were applied only to the middle two rows of plots that were four rows wide and 50 feet long at Champaign and four rows wide and 80 feet long at Bloomington. Treatments were assigned to plots using a randomized complete block design with 4 replications. Two untreated checks were included in the study at Champaign, six untreated checks were included at Bloomington. Root damage was evaluated as previously described except that five roots were dug from each treated row in each plot (2 rows x 5 roots x 4 replications = 40 observations) unless otherwise noted in the results.

Planting-time and cultivation-time treatments were applied in one of the following ways:

(1) Counter 15G, included for comparative purposes at Champaign, was applied at planting time in a 7-inch band ahead of the firming wheels and incorporated with spring tines mounted to the rear of each planter unit. Many other registered and experimental chemical soil insecticides were applied as previously described at Bloomington.

(2) Both the nematodes and the fungi were applied using the sub-surface banding tool previously described for applications of Lorsban 4E at Bloomington. The only significant differences were that applications were

made at a lower pressure of 15 psi to reduce the potential for mortality of the organisms as they passed through the nozzle orifice, and the liquid solutions containing the living organisms were applied deeper in the soil (5-6 inches).

(3) Both the nematodes and the fungi were also applied at planting time with modified anhydrous knives mounted in place of the sub-surface banding tools on the planter. The openings on the tubing attached to the back of the knife shank, typically used to deliver anhydrous ammonia, were braised closed and two new openings (1/16 inch diameter) were drilled on either side of the tubing. This allowed two streams of liquid to be applied in front of the planter units in the center of the row approximately 4-5 inches deep in the soil. These applications were also made at 15 psi.

(4) Both the nematodes and the fungi were applied at cultivation time with modified anhydrous knives. The knives were modified as described above except that instead of two openings (1/16 inch diameter), only one opening per knife was drilled. Four knives were then mounted on the cultivator. They were placed so that liquids could be delivered 3-4 inches underground on either side of the middle two rows of corn. In order to avoid root-pruning, the knives were placed about 3 inches to the side of the row and cultivation treatments were applied 19 days after planting when the plants were still relatively small.

A 5 percent agar solution was used as a carrier for the nematodes. The compressed air delivery system was calibrated with the agar solution before the nematodes were added in order to determine flow rates. Planting-time rates of 5,000, 10,000, 20,000, and 100,000 nematodes per linear meter of row were applied at Champaign with the application devices described in (2) and (3) above. At Bloomington, a rate of 20,000 nematodes per linear meter of row was applied using the sub-surface banding tool described in (2) above.

Conidia from both _Beauveria_ _bassiana_ isolates (1 and 2, Table 15) were suspended in water as a carrier for the applications. Both strains of fungi were applied at planting time at a rate of 10^{14} conidia per acre with the application devices described in (2) and (3) above.

Cultivation treatments of both organisms were applied with the same carriers, 5 percent agar solution for the nematodes and water for the fungi. Only one rate of nematodes (10,000 per linear meter of row) was applied at cultivation time at both the Champaign and Bloomington locations. Nematode treatments were applied as described in (4) above. Both isolates of _Beauveria_ _bassiana_ (1 and 2) were applied at a rate of 10^{14} conidia per acre at cultivation with the equipment described in (4) above.

Because this was our first hands-on experience with sub-surface banding equipment, efforts were made at Champaign to determine where the solutions were actually being placed below the soil surface:

(1) After the applications were made, soil was removed from around the sub-surface equipment before the planter was raised. The distance (in inches) from the soil surface to the openings on the sub-surface tool was recorded.

(2) Soil cores (6 inches deep) were removed from the center of the row and at 2-inch and 4-inch intervals on either side of the row for one Beauveria isolate (1). The samples are currently being evaluated so that a three-dimensional picture of the distribution pattern beneath the soil can be determined.

RESULTS AND DISCUSSION

The results of this year's root ratings and stand count data are presented in Tables 10 through 15. A summary of agronomic and experimental factors is presented in Tables 16A and 16B.

Bloomington

The results of both the root rating and stand count evaluations conducted at Bloomington are shown in Table 10. Between planting time on 22 May and the "root dig" on 18 July, more than 12 inches of rain fell on this plot (Appendix A-3).

The corn rootworm larval pressure was extremely heavy at the Bloomington location in 1986 (average root rating of 5.84 in the untreated checks). In many of the plots, stunted and lodged plants were observed on 18 July when the roots were evaluated for feeding damage. Despite the severe insect pressure, many registered and experimental products provided excellent rootworm control in this study. However, some products did not provide an acceptable level of control.

Registered granular soil insecticides applied at planting. Except for Furadan 15G, all registered granular products applied ahead of the firming wheels at planting time provided acceptable to excellent control (average root ratings of 3.0 or less). The average root ratings for these products were significantly lower than the average root rating in the untreated check. Both Counter 15G and Lorsban 15G applied in furrow also provided excellent rootworm control (average root ratings of 2.15 and 2.55, respectively, significantly lower than the average root rating in the untreated check).

The average root rating for Furadan 15G applied as a band at planting was not statistically different from the average root rating in the untreated check. Furadan 15G applied in furrow provided slightly better control than when applied in a band (average root ratings of 4.5 and 5.75, respectively), but the level of control was still unacceptable. The performance of Furadan at planting time at this location indicates that this field may have had a history of Furadan use in the past.

Placement of granular soil insecticides. In our trials in 1985, the placement of both Counter 15G and Lorsban 15G behind the firming wheels and not incorporated seemed to decrease the level of control. This placement and lack of incorporation did not significantly affect the level of control provided by Counter 15G in 1986 (average root rating of 2.3), but again significantly reduced the level of control provided by Lorsban 15G (average root rating of 3.35). The rain that fell on the plot after application at planting time may have helped to incorporate Counter 15G into the soil, and,

thus, improve performance. Furadan 15G applied behind the firming wheels at planting time did not provide acceptable control even though the average root rating (4.85) was statistically lower than the average root rating in the untreated check.

Registered granular soil insecticides applied at cultivation. Counter 15G, Dyfonate 20G, Mocap 15G, and Thimet 20G applied at cultivation time provided excellent rootworm control (average root ratings all below 3.0 and significantly lower than the average root rating in the untreated check). The average root ratings for Furadan 15G, Lorsban 15G, and Broot 15GX applied at cultivation time were all significantly lower than the average root rating in the untreated check but were all above 3.0. It is interesting to note that Furadan 15G applied at cultivation (average root rating of 3.55) provided significantly better rootworm control than Furadan 15G applied at planting (average root rating of 5.75). These results suggest that even when a planting-time application of Furadan fails to provide rootworm control, an application of Furadan at cultivation may still provide some protection of the root system.

Liquid insecticides. The average root ratings for all of the liquid insecticides, applied either at planting time or at cultivation time, were all above 3.0. However, the average root ratings for CGA-12223 4E applied at planting, trimethacarb 50W applied at planting, and Dyfonate 4.6MS, Lorsban 4E, and Furadan 4F applied at cultivation were significantly lower than the average root rating in the untreated check. The average root ratings for trimethacarb 50W applied at cultivation, and Furadan 4F, Dyfonate 4E, and Lorsban 4E applied in a band at planting time were not statistically different from the average root rating in the untreated check. Lorsban 4E applied as a sub-surface band provided no rootworm control at all (average root rating of 5.98).

Union Carbide's trimethacarb 50W did not provide acceptable rootworm control as either a planting-time or cultivation-time treatment. The stainless steel containers we use for our liquid applications have internal drop tubes that allow air to enter and pressurize the containers near the bottom. The air flow creates some agitation of products in the containers. However, for trimethacarb, a wettable powder, this agitation was not sufficient to keep the product in suspension. This may, in part, account for this product's poor performance.

Experimental soil insecticides. Most of the experimental granular products provided acceptable to excellent control when applied at planting time. DuPont's SD-208304, Stauffer's SC-0567, Avery's UBI-B8451, FMC's FMC-67825, ICI Americas' PP-993, Pennwalt's TD-2208 and TD-2209, and BASF's Lance 15G all had average root ratings of 3.0 or less. The average root ratings for certain rates of SD-208304 and SC-0567 applied at planting time were significantly lower than the average root ratings for many of the labeled uses of currently registered soil insecticides. The average root rating for Eli Lilly's EL-499 was significantly lower than the average root rating in the untreated check but was somewhat inconsistent among replications.

Carbamates. Broot 15GX and Lance 15G, both carbamates, provided acceptable rootworm control when applied at planting time in this study (average root ratings of 2.3 and 2.93, respectively). However, other carbamates (Furadan 15G and 4F, trimethacarb 50W, and Avery's UBI-A920) applied at planting time were ineffective in controlling the larvae. We had no reason to suspect that this site was a Furadan problem field, but, in retrospect, it now seems evident that this field is a Furadan-problem location and that some of the other carbamates were similarly affected. However, it is important to note that not all carbamates "failed" at this location, as indicated in the first sentence of this paragraph.

Nematodes. Planting-time and cultivation-time applications of the nematodes did not provide acceptable rootworm control (average root ratings not significantly different from the average root rating in the untreated check). Many of the plants in the nematode-treated plots were severely stunted and lodged when the roots were dug and evaluated on 18 July, and some of these seriously injured plants did not survive. A more in-depth explanation about these nematodes can be found in the "Champaign - Biological Studies" section.

Stand counts. Based on the stand count data, it appears that Stauffer's SC-0567, when placed in furrow, may cause some phytotoxicity problems. Although the average stand counts in the plots treated with SC-0567 in furrow were not statistically different from the average stand count in the untreated check, the trend toward a lower stand count is obvious. However, no burning or other phytotoxicity symptoms were observed in the field.

Bolton

The results of both the root rating and stand count evaluations conducted at Bolton are shown in Table 11. Between planting time on 8 May and the "root dig" on 15 July, almost 10 inches of rain fell on this plot (Appendix A-4).

The rootworm pressure at this location where corn was planted no-till into corn stubble was light in the untreated check (average root rating of 2.95). However, the average root ratings for Furadan 4F, EM Industries' CME-16003 5G, and Dyfonate 4E were greater than 3.0. These results suggest that the rootworm infestation at this location was very spotty and that certain areas in the field had "economic" populations of larvae.

Under the circumstances within this plot, all products held the average root rating below 3.0, with exceptions noted in the previous paragraph. Although statistical differences in root ratings among the various treatments occurred, the differences are really of no consequence because of the light infestation. These statistical differences in average root ratings commonly occur in plots where there is little variability in the data.

The stand in this field was very spotty, attributable to both the hard, packed soil conditions and a reported infestation of cutworms. It is interesting to note that statistical differences among stand counts occurred, but these differences could not be attributed to the various

treatments because evaluations for cutworm damage were not made. The average stand counts in the plots treated with PP-993 and Lorsban 15G were significantly higher than the average stand counts in plots treated with several other insecticides, but not statistically different from the average stand count in the untreated check.

Henry

The results of both the root rating and stand count evaluations conducted at Henry are shown in Table 12. Between planting time on 13 May and the "root dig" on 17 July, more than 15.5 inches of rain fell on this plot (Appendix A-5).

The rootworm pressure was heavy at Henry (average root rating of 5.16 in the untreated check). However, because of an error we made during the application of insecticides at cultivation, data from several treatments had to be omitted. We elected to evaluate any treatment for which we could obtain data from at least three replications. As a consequence, the data and comparisons among treatments should be viewed appropriately.

The average root ratings for all insecticide treatments were statistically lower than the average root rating in the untreated check. However, the average root ratings for Mocap 15G, EL-499 10G, Furadan 4F, and Dyfonate 4E were all 3.0 or higher and were significantly higher than the average root ratings of the other products. Again we emphasize that these data should be viewed with caution.

Statistical differences occurred among the average stand counts for the various treatments, but the reasons for these differences are unknown.

Monmouth

The results of both the root rating and stand count evaluations conducted at Monmouth are shown in Table 13. Between planting time on 9 May and the "root dig" on 16 July, more than 12 inches of rain fell on this plot (Appendix A-6).

The rootworm pressure at Monmouth was moderate (average root rating of 4.18 in the untreated check).

Registered granular soil insecticides. Except for Furadan 15G, the average root ratings for all registered granular insecticides applied both at planting time and at cultivation time were lower than 3.0 (except Lorsban 15G at cultivation, 3.05) and were significantly lower than the average root rating in the untreated check. Again, Counter 15G and Lorsban 15G applied in furrow provided good rootworm control (average root ratings of 2.1 and 2.5, respectively).

The average root ratings for Furadan 15G applied both in furrow and in a 7-inch band at planting (4.0 and 4.15, respectively) were not statistically different from the average root rating in the untreated check. The average root rating for Furadan 4F applied at planting was significantly higher than

the average root rating in the untreated check. However, the average root ratings for both Furadan 15G and 4F applied at cultivation were below 3.0 (2.45 and 2.7, respectively) and were significantly lower than the average root rating in the untreated check. We knew a priori that this location has had a history of Furadan use, and Furadan had "failed" in trials conducted at this location in previous years. However, these results are similar to the results from the Bloomington location and again indicate that Furadan applied at cultivation will provide some level of root protection even in "aggressive soils."

Liquid insecticides. Although the average root rating for Dyfonate 4E applied at planting time (3.2) was significantly lower than the average root rating in the untreated check, it was still above 3.0. Furadan 4F applied at planting provided no rootworm control. Based on these results and on the reults from Bloomington, we believe that the application of currently registered liquids at planting time is not a good approach for rootworm control.

Experimental soil insecticides. All of the experimental products, regardless of timing of application, had average root ratings that were significantly lower than the average root rating in the untreated check. In contrast to the results in other studies, Eli Lilly's product, EL-499, performed more consistently in this study.

Carbamates. Although Furadan applied at planting did not perform well at this location for reasons mentioned previously, Avery's UBI-A920, also a carbamate, did not exhibit the same performance problems. This further adds to the carbamate mystery because UBI-A920 performed poorly at Bloomington where Furadan also had problems.

Champaign - Furadan Formulation Study

The results of both the root rating and stand count evaluations conducted in the Furadan formulation study at Champaign are shown in Table 14. Between planting time on 2 June and the "root dig" on 23 July, almost 8.5 inches of rain fell on this plot (Appendix A-1).

Rootworm pressure for the Furadan formulation study was practically nonexistent (average root rating of 1.95 in the untreated check). The roots were evaluated on 23 July. Because this plot was established later in the season (2 June), it is likely that the plants may have escaped most of the larvae present during June. Only a few of the roots evaluated in this study rated a 3.0 in terms of feeding damage. Because of this low level of pressure, the results in Table 14 do not reflect comparisons under "worst case" conditions. Consequently, even though statistical differences are shown, no conclusions should be infered from these data. No differences among stand counts were observed.

Champaign - Biological Studies

The results of both the root rating and stand count evaluations conducted in the biological study at Champaign are shown in Table 15. Between planting time on 21 May and the "root dig" on 14 July, more than 11 inches of rain fell on this plot (Appendix A-1).

The rootworm pressure for the biological study was moderate to light (average root rating of 3.35 in the untreated check). The results from the "root digs" conducted on 14 July were confounded by the tremendous amount of regrowth on the root systems dug from these plots. Rainfall in combination with the apparently vigorous rooting behavior of the corn hybrid used for this study produced regrowth on the roots that made damage evaluations very difficult. In addition, even though many of the root systems had an average root rating of 3.0 or higher, we doubt whether any yield reductions would have occured because the tremendous amount of regrowth probably compensated for the rootworm larval damage.

Soil moisture, believed to be critical for the survival of steinernematid nematodes, was plentiful at this location. Nearly 2.7 inches of rain fell in May, followed by 4.4 inches in June and 4.7 inches in July (Appendix A-1).

The average root rating for Counter 15G applied at planting time (1.84) was significantly lower than the average root ratings for all of the biological organisms and for the untreated check. Average root ratings for many of the biological treatments were numerically but not statistically lower than the average root rating in the untreated check.

Although the data for the biological products are rather ambiguous, some trends are apparent. Lower rates of the nematodes applied at planting (5,000/m, 10,000/m, and 20,000/m) seemed to provide better control than did the higher rate applied at planting (100,000/m), although the differences in root ratings were not always significant. Also, the sub-surface band seemed to be a better method of application for both biological products, although exceptions to this are also apparent. Finally, with only one exception, planting-time treatments seemed to provide better control than did cultivation-time treatments.

A preliminary bioassay was conducted to determine the efficacy of the nematodes against southern corn rootworm (SCR) larvae in the laboratory. Nematodes were pipetted into diet cups filled 2/3 full with soil at the following rates: (1) 5,000 nematodes; (2) 500 nematodes; and (3) 50 nematodes. The soil in each cup was stirred after the nematodes were introduced. After 24 hours, 5 SCR larvae were placed in each cup. The nematodes infected all the SCR larvae in each cup at all rates tested. Given these laboratory results, we are somewhat puzzled as to why the nematodes performed so poorly at Bloomington, although many chemical products also "failed" under the extreme rootworm pressure. Similarly, questions still remain about the performance of both the nematodes and the fungi at Champaign. It is obvious that the bioassay results obtained in the laboratory (100 percent infection) did not translate into results in the field. Many questions concerning application methods, movement of the organisms in the soil, and field-infection rate still remain.

Beauveria bassiana isolates, unlike nematodes, are stationary organisms that remain where they are placed in the soil. Their "movement" in the soil would have to be via the hyphal growth of a colony. As a consequence, placement is probably more critical for these fungi than for the nematodes.

Based on preliminary findings from the soil samples taken for one Beauveria isolate, it seems that the sub-surface banding tool created a "kidney-shaped" band beneath the soil surface. The dimensions of the band were 2 1/2 to 5 inches deep and approximately 5 inches wides. Preliminary data for the anhydrous knife used at planting time indicate that the distribution pattern was somewhat circular (about 1-2 inches in diameter) and resembled a piece of pipe lying 4-5 inches below the soil surface and running the length of the row. The slight numerical advantages in the average root ratings for Beauvaria applied with the sub-surface banding tool might have been accounted for by the better distribution afforded by this method of application.

CONCLUSIONS

Registered granular soil insecticides applied at planting. Under the circumstances in which these products were tested, the performance of almost all of the registered compounds at all locations was very good. Except for Furadan, all of the products applied at planting time provided good rootworm control. Even when Counter and Lorsban were applied behind the firming wheels at Bloomington, these products performed very well.

Registered granular soil insecticides applied at cultivation. With few exceptions, all granular insecticides applied at cultivation provided good rootworm control. Lorsban 15G and Broot 15GX provided marginal to poor control when applied at cultivation. Both of these products are rather insoluble and often do not work well if soil moisture is limited after application.

Experimental soil insecticides. Many of the experimental compounds we evaluated in our rootworm control trials provided consistently good to excellent control. DuPont's SD-208304, Stauffer's SC-0567, and Avery's UBI-B8451 were consistently at the top of the root rating tables. ICI's PP-993, a pyrethroid soil insecticide, has performed consistently in the past and continues to provide very good rootworm control. FMC's 67825 and Pennwalt's TD-2208 and TD-2209 also look promising for the future.

Carbamates. Furadan 15G and 4F applied at planting time at both Bloomington and Monmouth, both Furadan-problem sites, provided poor control of rootworm larvae. The performance of Furadan was improved considerably when it was applied at cultivation at both locations. Both UBI-A920 and the liquid formulation of Broot (trimethacarb 50W) also failed to provide acceptable rootworm control at Bloomington. However, both Broot 15GX and Lance 15G applied at planting at Bloomington provided acceptable rootworm control, and UBI-A920 applied at Monmouth also provided acceptable control.

If the poor performance of most of the carbamates was caused by enhanced microbial degradation in our trials, it seems possible that when these chemicals are applied at cultivation, they may persist long enough to provide adequate or at least moderate rootworm control.

Both Furadan 15G and Lance 15G applied at planting at the Henry site provided good rootworm control. This field has not had a history of Furadan use.

Liquid insecticides. With the exception of Furadan 4F applied at cultivation at Monmouth, none of the liquid insecticide applications provided acceptable rootworm control. Because of the inconvenience of banded liquid applications and the more toxic nature of liquid insecticides, most growers will probably choose not to handle liquid soil insecticides at planting. Based on our results, the level of control achieved with liquid rootworm soil insecticides would not be acceptable to most growers anyway.

Biological studies. The results from the biological studies we conducted in 1986 were not promising. However, many factors could have influenced the performance of these products, not the least of which was method of application. Further studies are necessary to determine the potential for biological organisms in control programs for corn rootworm larvae. Much more knowledge about these organisms' behavior and survival under natural field conditions is necessary before the practical aspects of their use can be fully determined.

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Table 10. Corn rootworm soil insecticide evaluation, Bloomington, McLean County, Illinois, 1986.

Product	Rate (lb ai/A)[1]	Method of application	Mean root rating[2,3]	Stand count[3,4]
SD-208304 15G	0.75	7-in. band	1.15 a	25.75 a
SC-0567 5G	1.0	furrow	1.27 ab[5]	21.75 f
SD-208304 15G	1.0	7-in. band	1.30 a-c	23.75 a-f
UBI-B8451 15G	1.0	7-in. band	1.40 a-d	24.00 a-f
SC-0567 5G	0.5	7-in. band	1.45 a-e	22.75 d-f
Counter 15G	1.0	7-in. band	1.60 a-f[5]	22.50 ef
Counter 15G	1.0	cultivation	1.65 a-g	24.00 a-f
FMC-67825 20G	0.75	7-in. band	1.67 a-h[5]	24.25 a-e
SC-0567 5G	0.5	furrow	1.67 a-h[5]	22.75 d-f
SC-0567 5G	1.0	7-in. band	1.70 a-h	23.50 a-f
FMC-67825 20G	1.0	7-in. band	1.80 a-i	24.00 a-f
Dyfonate 20G	1.0	7-in. band	1.90 a-j	24.25 a-e
SC-0567 5G	0.25	furrow	1.90 a-j	23.50 a-f
Dyfonate 20G (clay)	1.0	7-in. band	2.00 a-j	23.75 a-f
SC-0567 5G	0.25	7-in. band	2.00 a-j	24.75 a-e
Thimet 20G	1.0	7-in. band	2.00 a-j	24.25 a-e
Lorsban 15G	1.0	7-in. band	2.05 b-j	22.75 d-f
PP-993 1.5G	0.1	7-in. band	2.05 b-j	25.00 a-d
Counter 15G	1.0	furrow	2.15 c-k	25.00 a-d
PP-993 1.5G	0.125	7-in. band	2.15 c-k	23.25 c-f
Dyfonate 20G	1.0	cultivation	2.20 d-l	25.00 a-d
Broot 15GX	1.0	7-in. band	2.30 e-l	25.00 a-d
Counter 15G	1.0	7-in. band[6] (no incorp.)	2.30 e-l	23.00 c-f
TD-2209 15G	0.75	7-in. band	2.30 e-l	23.75 a-f
Mocap 15G	1.0	7-in. band	2.35 f-m	24.50 a-e
FMC-67825 20G	1.0	cultivation	2.45 f-m	25.00 a-d
TD-2208 15G	1.0	7-in. band	2.45 f-m	24.25 a-e
Thimet 20G	1.0	cultivation	2.45 f-m	23.25 b-f
TD-2208 15G	1.0	furrow	2.50 g-n	25.00 a-d
FMC-67825 20G	0.75	cultivation	2.55 h-n	24.00 a-f
Lorsban 15G	1.0	furrow	2.55 h-n	23.00 c-f
Mocap 15G	1.0	cultivation	2.65 i-o	23.50 a-f
TD-2209 15G	1.0	7-in. band	2.65 i-o	25.00 a-d
TD-2208 15G	0.75	7-in. band	2.75 j-p	22.75 d-f
Lance 15G	1.0	7-in. band	2.93 k-q[5]	25.25 a-c
Aastar 15G	1.0	7-in. band	3.00 k-q	24.75 a-e

(continued)

Table 10. (continued)

Product	Rate lb ai/A[1]	Method of application	Mean root rating[2,3]	Stand count[4]
TD-2209 15G	1.0	furrow	3.00 k-q	25.00 a-d
EL-499 10G	0.37	7-in. band[6]	3.10 l-q	24.25 a-e
CGA-12223 4E	0.5	7-in. band	3.20 m-r[5]	24.25 a-e
EL-499 10G	0.49	7-in. band[6]	3.35 n-s	23.50 a-f
Lorsban 15G	1.0	7-in. band[6] (no incorp.)	3.35 n-s	25.00 a-d
Lorsban 15G	1.0	cultivation	3.45 o-t	25.00 a-d
Furadan 15G	1.0	cultivation	3.55 p-t	24.00 a-f
Trimethacarb 50W	1.0	7-in. band	3.73 q-u[5]	25.50 ab
Broot 15GX	1.0	cultivation	4.00 r-v	24.75 a-e
UBI-A920 15G	1.0	7-in. band	4.10 s-w	24.25 a-e
Dyfonate 4.6MS	1.0	cultivation	4.20 t-w	23.75 a-f
Furadan 15G	1.0	furrow	4.50 u-w	23.50 a-f
Lorsban 4E	1.0	cultivation	4.50 u-w	24.00 a-f
Furadan 4F	1.0	cultivation	4.65 v-x	24.50 a-e
Furadan 15G	1.0	7-in. band[6] (no incorp.)	4.85 w-x	23.25 b-f
Trimethacarb 50W	1.0	cultivation	5.30 xy	24.75 a-e
Furadan 4F	1.0	7-in. band	5.60 y	23.25 b-f
Furadan 15G	1.0	7-in. band	5.75 y	24.25 a-e
Untreated Check	...	...	5.84 y[7]	23.79 a-f
Nematodes	20,000[8]	7-in. band (subsurface)[9]	5.88 y[7]	24.25 a-e
Nematodes	10,000[8]	cultivation (an. knives)[10]	5.94 y[7]	24.75 a-e
Dyfonate 4E	1.0	7-in. band	5.95 y	25.25 a-c
Lorsban 4E	1.0	7-in. band (subsurface)[11]	5.98 y[7]	23.25 b-f
Lorsban 4E	1.0	7-in. band	6.00 y	23.50 a-f

Footnotes for Table 10:

[1] Rate based on 40-inch row spacing.

[2] Root-damage rating scale includes six categories ranging from no damage (1) to severe damage (6). Mean is based on 20 observations (4 replications x 5 roots per treatment) except where noted.

[3] Means in a column followed by the same letter are not significantly different (DMRT, p=0.1).

[4] Mean stand count is based on 4 observations (1/1,000 acre sample x 4 replications.

[5] Missing observations (fewer than 20).

[6] Insecticide applied behind the firming wheels of the planter.

[7] More than 20 observations.

[8] Number of entomogenous nematodes per linear meter of row.

[9] Liquid applied approximately 5 to 6 inches below the soil surface with specially designed sweeps.

[10] Liquid applied approximately 4 inches below the soil surface with modified anhydrous knives.

[11] Liquid applied approximately 3 to 4 inches below the soil surface with specially designed sweeps.

Table 11. Corn rootworm soil insecticide evaluation, Bolton, Stephenson County, Illinois, 1986.

Product	Rate lb ai/A[1]	Method of application	Mean Root rating[2,3]	Stand count[3,4]
Counter 15G	1.0	7-in. band	1.15 a	17.50 b-d
Counter 15G	1.0	furrow	1.55 ab	20.50 a-d
Lance 15G	1.0	7-in. band	1.75 a-c	18.75 a-d
PP-993 1.5G	0.1	7-in. band	1.90 b-d	23.00 a
FMC-67825 20G	0.75	7-in. band	1.90 b-d	17.00 cd
Aastar 15G	1.0	7-in. band	2.00 b-d	21.50 ab
Dyfonate 20G	1.0	7-in. band	2.05 b-d	19.75 a-d
Lorsban 15G	1.0	furrow	2.05 b-d	21.50 ab
CGA-12223 10G	0.5	furrow	2.05 b-d	17.25 b-d
Furadan 15G	1.0	furrow	2.10 b-e	17.75 b-d
FMC-67825 20G	1.0	7-in. band	2.15 b-e	19.50 a-d
Thimet 20G	1.0	7-in. band	2.25 b-f	19.75 a-d
Lorsban 15G	1.0	7-in. band	2.30 b-f	22.75 a
CME-16003 5G	0.5	7-in. band	2.35 c-g	20.00 a-d
Broot 15GX	1.0	7-in. band	2.40 c-g	20.50 a-d
Mocap 15G	1.0	7-in. band	2.40 c-g	16.25 d
CGA-12223 20G	0.5	7-in. band	2.50 c-g	18.00 b-d
Furadan 15G	1.0	7-in. band	2.60 d-h	20.75 a-c
CGA-12223 10G	0.5	7-in. band	2.85 e-h	20.75 a-c
Untreated Check	...	...	2.95 f-i[5]	18.88 a-d
Furadan 4F	1.0	7-in. band	3.10 g-i	18.75 a-d
CME-16003 5G	1.0	7-in. band	3.25 hi	19.25 a-d
Dyfonate 4E	1.0	7-in. band	3.65 i	20.50 a-d

[1] Rate based on 40-inch row spacing.

[2] Root-damage rating scale includes six categories ranging from no damage (1) to severe damage (6). Mean is based on 20 observations (4 replications x 5 roots per treatment) except where noted.

[3] Means in a column followed by the same letter are not significantly different (DMRT, p=0.1).

[4] Mean stand count is based on 4 observations (1/1,000 acre sample x 4 replications.

[5] More than 20 observations.

Table 12. Corn rootworm soil insecticide evaluation, Henry, Marshall County, Illinois, 1986.

Product	Rate lb ai/A[1]	Method of application	N[2]	Mean root rating[3,4,5]	Stand count[5,6]
Counter 15G	1.0	7-in. band	4	1.95 a	25.75 a
Lance 15G	1.0	7-in. band	3	2.06 a	22.67 b-e
FMC-67825 20G	0.75	7-in. band	3	2.13 a	24.00 b-d
SD-208304 15G	0.75	7-in. band	3	2.13 a	24.33 a-d
SD-208304 15G	1.0	7-in. band	3	2.13 a	24.67 a-d
FMC-67825 20G	1.0	7-in. band	3	2.20 a	20.67 e
PP-993 1.5G	0.1	7-in. band	4	2.25 a	25.00 a-c
Aastar 15G	1.0	7-in. band	4	2.35 a	25.50 ab
Lorsban 15G	1.0	furrow	4	2.45 a	22.25 c-e
Furadan 15G	1.0	furrow	3	2.47 a	22.50 c-e
Lorsban 15G	1.0	7-in. band	4	2.50 a	25.75 a
Mocap 15G	1.0	cultivation	3	3.00 b	22.67 b-e
EL-499 10G	0.49	7-in. band[7]	3	3.60 b	23.00 a-e
Furadan 4F	1.0	7-in. band	4	3.75 b	22.33 c-e
Dyfonate 4E	1.0	7-in. band	3	3.80 b	22.00 de
Untreated Check	...	...	6	5.16 c	24.38 a-d

1 Rate based on 40-inch row spacing.

2 Number of replications included in ANOVA.

3 Root-damage rating scale includes six categories ranging from no damage (1) to severe damage (6).

4 Mean root rating based on variable number of observations. See text for explanation.

5 Means in a column followed by the same letter are not significantly different (DMRT, p=0.1).

6 Mean stand count is based on 4 observations (1/1,000 acre sample x 4 replications.

7 Insecticide applied behind the firming wheels of the planter.

Table 13. Corn rootworm soil insecticide evaluation, Monmouth, Warren County, Illinois, 1986.

Product	Rate lb ai/A[1]	Method of application	Mean root rating[2,3]	Stand count[3,4]
PP-993 1.5G	0.125	7-in. band	1.85 a	26.00 a-e
Mocap 15G	1.0	7-in. band	1.90 ab	25.25 a-g
SD-208304 15G	1.0	7-in. band	1.95 a-c	25.75 a-f
UBI-B8451 15G	1.0	7-in. band	1.95 a-c	26.50 a-d
Dyfonate 20G (clay)	1.0	7-in. band	2.00 a-d	23.75 e-g
PP-993 1.5G	0.1	7-in. band	2.05 a-d	27.50 a
Counter 15G	1.0	7-in. band	2.10 a-e	25.75 a-f
Counter 15G	1.0	furrow	2.10 a-e	26.25 a-e
FMC-67825 20G	1.0	cultivation	2.10 a-e	24.00 d-g
Dyfonate 20G	1.0	7-in. band	2.15 a-e	24.50 c-f
FMC-67825 20G	1.0	7-in. band	2.15 a-e	23.00 g
SD-208304 15G	0.75	7-in. band	2.15 a-e	25.50 a-g
FMC-67825 20G	0.75	7-in. band	2.20 a-e	23.75 e-g
TD-2208 15G	1.0	furrow	2.30 a-f	25.25 a-g
Counter 15G	1.0	cultivation	2.35 a-f	23.75 e-g
TD-2209 15G	1.0	7-in. band	2.35 a-f	24.50 c-g
Furadan 15G	1.0	cultivation	2.45 a-g	25.00 a-g
Mocap 15G	1.0	cultivation	2.47 a-g[5]	25.75 a-f
Lorsban 15G	1.0	7-in. band	2.50 a-g	24.00 d-g
Lorsban 15G	1.0	furrow	2.50 a-g	24.75 b-g
TD-2208 15G	1.0	7-in. band	2.55 a-h	25.50 a-g
Thimet 20G	1.0	cultivation	2.60 a-h	24.25 d-f
UBI-A920 15G	1.0	7-in. band	2.60 a-h	25.50 a-g
Thimet 20G	1.0	7-in. band	2.65 b-h	23.00 g
FMC-67825 20G	0.75	cultivation	2.67 b-h[5]	25.00 a-g
EL-499 10G	0.37	7-in. band[5]	2.70 c-h	24.50 c-f
Furadan 4F	1.0	cultivation	2.70 c-h	24.00 d-g
Aastar 15G	1.0	7-in. band	2.75 d-h	25.75 a-f
TD-2208 15G	0.75	7-in. band	2.75 d-h	24.50 c-f
TD-2209 15G	0.75	7-in. band	2.75 d-h	25.25 a-g
TD-2209 15G	1.0	furrow	2.75 d-h	25.25 a-g
Dyfonate 20G	1.0	cultivation	2.85 e-h	27.00 a-c
EL-499 10G	0.49	7-in. band[6]	3.00 f-h	25.50 a-g
Lorsban 15G	1.0	cultivation	3.05 f-h	24.25 d-g
Dyfonate 4E	1.0	7-in. band	3.20 g-h[5]	23.25 fg
Lorsban 4E	1.0	cultivation	3.30 h	27.25 ab
Furadan 15G	1.0	7-in. band	4.00 i	24.00 d-g
Furadan 15G	1.0	furrow	4.15 i	25.50 a-g
Untreated Check	...	...	4.18 i[7]	24.38 c-g
Furadan 4F	1.0	7-in. band	4.90 j	24.50 c-g

Footnotes for Table 13:

[1] Rate based on 40-inch row spacing.

[2] Root-damage rating scale includes six categories ranging from no damage (1) to severe damage (6). Mean is based on 20 observations (4 replications x 5 roots per treatment) except where noted.

[3] Means in a column followed by the same letter are not significantly different (DMRT, p=0.1).

[4] Mean stand count is based on 4 observations (1/1,000 acre sample x 4 replications.

[5] Missing observations (fewer than 20).

[6] Insecticide applied behind the firming wheels of the planter.

[7] More than 20 observations.

Table 14. Corn rootworm soil insecticide evaluation, Champaign, Champaign County, Illinois, 1986.

Product	Rate (lb ai/A)[1]	Method of application	Mean root rating[2,3]	Stand count[3,4]
Counter 15G	1.0	7-inch band	1.10 a	23.50 a
Furadan CR-10	1.0	7-inch band	1.50 b	24.75 a
Furadan CG	1.0	7-inch band	1.65 bc	24.75 a
Furadan 15G	1.0	7-inch band	1.80 bc	25.50 a
Furadan 30/60	1.0	7-inch band	1.80 bc	24.50 a
Untreated Check	...	...	1.95 c	25.75 a

1 Rate based on 40-inch row spacing.

2 Root-damage rating scale includes six categories ranging from no damage (1) to severe damage (6). Mean is based on 20 observations (4 replications x 5 roots per treatment).

3 Means in a column followed by the same letter are not significantly different (DMRT; p=0.1).

4 Mean stand count is based on 4 observations (1/1,000 acre sample x 4 replications.

Table 15. Corn rootworm biological control evaluation, Champaign, Champaign County, Illinois, 1986.

Product	Rate	Method of Application	Mean root rating[1,2]	Stand count[2,3]
Counter 15G	1.0[4]	7-inch band	1.84 a	22.63 a-e
S. feltiae	5,000/m[5]	subsurface band[6]	2.89 b	24.13 a-c
B. bassiana (2)	10^{14} conidia[7]	AK-cultivation[8]	3.00 bc	24.38 ab
S. feltiae	10,000/m[5]	subsurface band[6]	3.05 b-d	21.63 c-e
S. feltiae	10,000/m[5]	anhydrous knife[8]	3.13 b-e	23.75 a-d
S. feltiae	20,000/m[5]	anhydrous knife[8]	3.17 b-e	22.63 a-e
S. feltiae	20,000/m[5]	subsurface band[6]	3.18 b-e	21.25 d-e
B. bassiana (1)	10^{14} conidia[7]	subsurface band[6]	3.20 b-e	22.63 a-e
B. bassiana (1)	10^{14} conidia[7]	anhydrous knife[8]	3.21 b-e	24.75 a
S. feltiae	10,000/m[5]	AK-cultivation[8]	3.30 b-e	21.00 e
S. feltiae	5,000/m[5]	anhydrous knife[8]	3.31 b-e[9]	22.00 b-e
Untreated Check	...	...	3.35 b-e[9]	22.81 a-e
B. bassiana (2)	10^{14} conidia[7]	anhydrous knife[8]	3.40 b-e	23.00 a-e
S. feltiae	100,000/m[5]	subsurface band[6]	3.40 b-e	21.38 de
B. bassiana (1)	10^{14} conidia[7]	AK-cultivation[8]	3.58 c-e	21.75 c-e
B. bassiana (2)	10^{14} conidia[7]	subsurface band[6]	3.60 de[10]	22.63 a-e
S. feltiae	100,000/m[5]	anhydrous knife[8]	3.68 e	23.00 a-e

[1] Root-damage rating scale includes six categories ranging from no damage (1) to severe damage (6). Mean is based on 40 observations (4 replications x 10 roots per treatment) except where noted.

[2] Means in a column followed by the same letter are not significantly different (DMRT, p=0.1).

[3] Mean stand count is based on 4 observations (1/1,000 acre sample x 4 replications.

[4] Rate based on 40-inch row spacing.

[5] Number of entomogenous nematodes per linear meter of row.

[6] Liquid applied approximately 5 to 6 inches below the soil surface in a band with specially designed sweeps (see text for description).

[7] Number of conidia per acre.

[8] Liquid applied approximately 4 inches below the soil surface with modified anhydrous knives (see text for description).

[9] Fewer than 40 observations.

[10] More than 40 observations.

Table 16A. Summary of agronomic and experimental factors for the 1986 corn rootworm soil insecticide evaluations.

	LOCATION		
	Bloomington	Bolton	Henry
Agronomic			
planting date	22 May	8 May	13 May
hybrid	Funks G4626	Victor 168-VS	Garst 8388
population/acre	26,100	26,100	26,100
row spacing	30"	30"	30"
soil condition at planting	top 2" moist	top 2" dry rough seed bed	top 2" dry 30-40% residue
wind at planting	calm	10-20 mph gusts from east	< 3 mph
previous crops	corn (85,83,82,81) beans (84,80)	corn silage (85) hay (85,84,83,82) corn (81,80)	corn (85,83,81) beans (84,82,80)
soil insecticide	Counter (83,82,79)	Dyfonate (85)	Counter (85)
cultivation (86)	12 June	none	11 June plenty/vol. corn
Herbicides	Atrazine 1 qt. 4L Dual 1 qt. 8E Bladex 2 lb. 80W	Bladex 1.5 lb. 80W Lasso 3 qt. 4EC Banvel .5 pt. 2-4 D .5 pt.	Lasso 2.5 qt. 4EC Atrazine 1.5 qt. 4L N 34 lb/acre
Fertilizer	P 70 lb/acre K 70 lb/acre Lime 2 ton/acre	liquid manure inj. 6000 gal/acre (85) 8000 gal/acre (86)	Urea 150 lb/acre P 40 lb/acre K 35 lb/acre
starter	none	none	N 55 lb/acre (irrigated)
Tillage			
fall	stalks shredded	none	none
spring	chisel/disk/field cultivator	none	offset disk/harrow

(continued)

Table 16A (contd).

Experimental			
stand count	19 June	29 May	30 May
root rating	18 July	15 July	17 July
Plots			
number of rows	1*	1	1
length	80'	100'	100'
replications	4	4	4

* Nematode and Lorsban 4E sub-surface plots - 2 rows.

Table 16B. Summary of agronomic and experimental factors for the 1986 corn rootworm soil insecticide evaluations.

	LOCATION		
		Champaign - U of I South Annex	
	Monmouth	Biological	Furadan formulation
Agronomic			
planting date	9 May	21 May	2 June
hybrid	Northrup King PX9540	Noble Bear 2401	Noble Bear 2401
population/acre	26,100	26,100	26,100
rows	30"	30"	30"
soil condition at planting	top 2" moist	top 2" moist	top 2" moist
wind at planting	< 3 mph	calm	calm
previous crops	corn (85,84,83,82) beans (81)	corn (85)	corn (85,83,82) beans (84,81)
soil insecticide	mixed	?	mixed (83)
cultivation (86)	10 June	9 June	16 June
Herbicides	Sutan+ 5.5 pt. Atrazine 1 qt 4L Bladex 1 qt 4L	Atrazine 1.5 qt 4L Bladex 2 qt 4L	Atrazine 1.5 qt 4L Bladex 2 qt 4L
Fertilizer	anhydrous 200 lb	N 200 lb/acre P 46 lb/acre K 60 lb/acre	N 200 lb/acre P 46 lb/acre K 60 lb/acre
starter	none	none	none
Tillage			
fall	none	none	none
spring	moldboard/field cultivator	moldboard/field cultivator	moldboard/field cultivator

(continued)

Table 16B (contd).

Experimental			
stand count	30 May	12 June	26 June
root rating	16 July	14 July	23 July
Plots			
number of rows	1	2	1
length	100'	50'	100'
replications	4	4	4

CONTROL OF ADULT CORN ROOTWORMS WITH AERIALLY APPLIED INSECTICIDES - FIRST-YEAR RESULTS (JULY AND AUGUST, 1986)

Principal Investigator: Stephen P. Briggs

Cooperators: Yordy Farms, Tazewell County, Morton, Illinois,
Mike Yordy, owner
Murray Brian, Brian Agricultural Aviation, Pekin, Illinois

Objective: The objective of this study was to document the efficacy of a new Cythion formulation, Sevin XLR, Penncap-M, and a Penncap-M/Sevin XLR combination for the control of corn rootworm adults in four continuous corn fields in central Illinois. Roots will be evaluated in 1987 from all fields except the Cythion test field to determine the extent of rootworm larval damage in relation to the timing of the sprays in 1986.

INTRODUCTION

The use of insecticides to control corn rootworm beetles and thereby prevent egg laying and larval damage during the following year was first introduced as an alternative to soil insecticides in the late 1970s. Although research efforts have shown that this approach can work, diligent scouting is necessary for its success.

Because corn growers have experienced rootworm control problems with some of the soil insecticides over the past few years, there has been increasing interest in controlling rootworm beetles to prevent egg laying. We resumed our research efforts in this area of study in 1986 to try to provide the most current information and to help determine guidelines for making this approach toward rootworm management work.

METHODS

Four fields located approximately 3 miles southeast of Morton, Illinois, in Tazewell County were selected for this study. The fields are in continuous corn production. A nonreplicated "strip test" in which Cythion was tested against Sevin XLR and an untreated check was established in Field 1. Fields 2, 3, and 4 were each divided into equally sized quadrants: one quadrant of the field was treated one time early (July 29); another quadrant of the field was treated one time late (August 12); another quadrant was treated twice, both early (July 29) and late (August 12); and the last quadrant was not treated. This experimental design is shown graphically in Figure 1.

Field 1 is approximately 30 acres in size and was planted to Pioneer 3475 on April 29, 1986. The field was divided into equal thirds. One third was treated with Sevin XLR at a rate of one quart per acre, one third was treated with Cythion (special formulation, 4.1 lb/gal) at a rate of one quart per acre, and one third was not treated. The insecticides were applied on July 29, 1986, in 2 gallons of finished spray per acre.

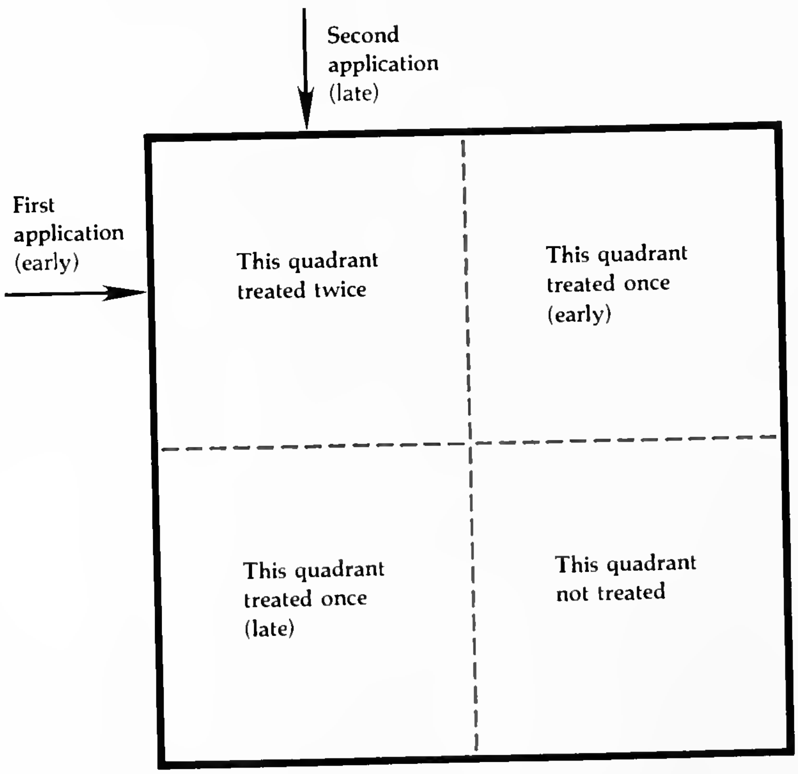
Field 2 is located at the northwest corner of Tennessee Avenue and Broadway Road and is approximately 80 acres in size. Pioneer 3615 was planted in the western half of the field and Pioneer 3747 was planted in the eastern half of the field on April 24, 1986. The western half of the field was treated on July 29, 1986, with one quart of Sevin XLR per acre. The northern half of the field was treated on August 12, 1986, with one quart of Sevin XLR per acre.

Field 3 is located at the southeast corner of Queensland Road and Tennessee Avenue, is approximately 58 acres in size, and was planted to Pioneer 3540 on April 25, 1986. The western half of the field was treated on July 29, 1986, with one quart of Penncap-M per acre. The northern half of the field was treated on August 12, 1986, with one quart of Penncap-M per acre.

Field 4 is located on the southwest corner of Route 121 and Broadway Road, is approximately 80 acres in size, and was planted to Pioneer 3377 on April 26, 1986. The western half of the field was treated with one pint of Sevin plus one pint of Penncap-M on July 29, 1986. The southern half of the field was treated with this same combination on August 12, 1986.

Counts of rootworm beetles in Field 1 were taken 5 days prior to treatment and 3, 6, and 13 days post-treatment. Counts of rootworm beetles in all quadrants of fields 2, 3, and 4 were taken 5 days prior to treatment and 6, 13, and 21 days post-treatment.

Figure 1. Diagram of the procedure for treating fields 2, 3, and 4 for control of corn rootworm beetles.



RESULTS

Field 1

<u>5 days pre-treatment counts</u> (July 24, 1986)

beetle counts = 3.25 beetles/plant (20 randomly selected plants)
sex ratio: Northern Corn Rootworms (NCR) - 10 males:36 females
Western Corn Rootworms (WCR) - 26 males:29 females
percent gravid: NCR - 5.5%
WCR - 6.9%
WCR/NCR ratio: 55/46 (46 percent NCR)

<u>3 days post-treatment counts</u> (August 1, 1986)
20 randomly selected plants per plot

Cythion = 0.85 beetle/plant
Sevin = 0.15 beetle/plant
Untreated check = 2.35 beetles/plant

<u>6 days post-treatment counts</u> (August 4, 1986)
20 randomly selected plants per plot

Cythion = 0.80 beetle/plant
Sevin = 0.20 beetle/plant
Untreated check = 1.60 beetles/plant

<u>13 days post-treatment counts</u> (August 11, 1986)
20 randomly selected plants per plot

Cythion = 0.60 beetle/plant
Sevin = 0.20 beetle/plant
Untreated check = 0.70 beetle/plant

Field 2

<u>5 days pre-treatment counts</u> (July 24, 1986)

beetle counts = 3.35 beetles/plant (20 randomly selected plants)
sex ratio: NCR - 21 males:43 females
WCR - 12 males:16 females
percent gravid: NCR - 2.3%
WCR - 18.8%
WCR/NCR ratio: 28/64 (70% NCR)

<u>6 days post-treatment counts</u> (August 4, 1986)
40 randomly selected plants per plot

Sevin = 0.18 beetle/plant
Untreated check = 1.45 beetles/plant

<u>13 days post-treatment counts</u> (August 11, 1986)
20 randomly selected plants per plot

Sevin = 0.20 beetle/plant
Untreated check = 0.85 beetle/plant

sex ratio: NCR - 20 males:1 female
WCR - 90 males:12 females
percent gravid: NCR - 0.0%
WCR - 20.0%
WCR/NCR ratio: 102/21 (83% Westerns)

<u>Second Treatment applied August 12, 1986</u>

<u>21 days after first treatment, 7 days after second treatment counts</u>
(August 19, 1986)
20 randomly selected plants per plot

Sevin sprayed once (21 days after first treatment) = 0.35 beetle/plant
Sevin sprayed twice = 0
Sevin sprayed once (7 days after second treatment) = 0
Untreated check = 0.70 beetle/plant

<u>August 25, 1986</u>

Untreated check = .05 beetle/plant (field near harvest)

Field 3

5 days pre-treatment counts (July 24, 1986)

beetle counts = 3.35 beetles/plant (20 randomly selected plants)
sex ratio: NCR - 8 males:34 females
WCR - 8 males:19 females
percent gravid: NCR - 2.9%
WCR - 0.0%
WCR/NCR ratio: 27/42 (61% NCR)

6 days post-treatment counts (August 4, 1986)
20 randomly selected plants per plot

Penncap-M = 0.10 beetle/plant
Untreated check = 0.95 beetle/plant

13 days post-treatment counts (August 11, 1986)
20 randomly selected plants per plot

Penncap-M = 0.40 beetle/plant
Untreated check = 1.05 beetles/plant

sex ratio: NCR - 29 males:7 females
WCR - 71 males:18 females
percent gravid: NCR - 14.3%
WCR - 88.9%
WCR/NCR ratio: 89/36 (71% Westerns)

Second Treatment applied August 12, 1986

21 days after first treatment, 7 days after second treatment counts
(August 19, 1986)
20 randomly selected plants per plot

Penncap-M sprayed once (21 days after first treatment) = 0.5 beetle/plant
Penncap-M sprayed twice = 0.15 beetle/plant
Penncap-M sprayed once (7 days after second treatment) = 0.05 beetle/plant
Untreated check = 0.85 beetle/plant

August 25, 1986

Untreated check = .20 beetle/plant

Field 4

5 days pre-treatment counts (July 24, 1986)

beetle counts = 2.85 beetles/plant (20 randomly selected plants)
sex ratio: NCR - 21 males:105 females
WCR - 4 males:22 females
percent gravid: NCR - 9.4%
WCR - 4.6%
WCR/NCR ratio: 26/126 (83% NCR)

6 days post-treatment counts (August 4, 1986)
20 randomly selected plants per plot

Sevin/Penncap-M = 0.1 beetle/plant
Untreated check = 1.1 beetles/plant

13 days post-treatment counts (August 11, 1986)
20 randomly selected plants per plot

Sevin/Penncap-M = 0.20 beetle/plant
Untreated check = 0.65 beetle/plant

sex ratio: NCR - 15 males:2 females
WCR - 22 males:8 females
percent gravid: NCR - 50.0%
WCR - 75.0%
WCR/NCR ratio: 30/17 (36% Westerns)

Second Treatment applied August 12, 1986

21 days after first treatment, 7 days after second treatment counts
(August 19, 1986)
20 randomly selected plants per plot

Sevin/Penncap-M sprayed once (21 days after first treatment) = 0.10 beetle/plant
Sevin/Penncap-M sprayed twice = 0
Sevin/Penncap-M sprayed once (7 days after second treatment) = 0.05 beetle/plant
Untreated check = 0.50 beetle/plant

August 25, 1986

Untreated check = .25 beetle/plant

DISCUSSION

The results so far indicate only that insecticides applied for control of corn rootworm beetles reduced their numbers considerably when compared to the untreated checks. However, our primary objective is to determine if the timing of the treatments in 1986 prevented a significant amount of egg laying by the females and will subsequently prevent damage to the corn roots in 1987. Strips of corn treated with soil insecticide and strips left untreated will be planted in 1987. Roots from these paired strips will be dug from all 4 quadrants (treated early, treated late, treated twice, and untreated) in fields 2, 3, and 4 in July of 1987. The data collected in 1987 will help us determine if the applications of insecticides to prevent egg laying were effective.

CONTROL OF 1ST AND 2ND GENERATION EUROPEAN CORN BORERS WITH AERIALLY APPLIED INSECTICIDES

Principal Investigators: Karl Kinney, Keith Hunter, Kevin Steffey

Cooperators: Chuck and Bob Kern, Kern Bros. Farms, Woodford Co., Eureka, IL
Don Cremer, Cremer Farms, Woodford Co., Minonk, IL
John Obery, Obery Farms, Woodford Co., Metamora, IL
Darel Walker, Asst. Co. Ag Adviser, Woodford Co., Eureka, IL
Bob Schertz, Schertz Aerial, EL Paso, IL
Murray Brian, Brian Agricultural Aviation, Pekin, IL

Objectives: The objectives of theses studies were to evaluate aerial applications of Dipel 10G and Lorsban 15G for control of 1st generation European Corn Borer (ECB) larvae, *Ostrinia nubilalis* Hubner, and to evaluate aerial applications of Dipel ES and Lorsban 4E for control of 2nd generation ECB larvae.

INTRODUCTION

The ECB is a recurrent annual problem for many corn producers in Illinois. Since its introduction into Illinois in Lake County in 1939, both the 1st and the 2nd generation of the ECB have caused annual yield reductions in corn. Recent estimates indicate that 10 percent of the cornfields in Illinois suffer a 9-15 percent yield reduction annually caused by ECB damage (Briggs and Guse 1986). As a consequence, producers of sweet corn, seed corn, and field corn must consider management of this major insect pest of corn every year. Steffey et al. (1987) present a more thorough discussion of ECB management in Illinois.

European corn borer larvae overwinter in Illinois in the base of corn stalks and in debris on the soil surface. They pupate in the spring, and moths emerge in May and June. Females mate and then oviposit on the underside of corn leaves during calm evenings. Moths laying eggs for the first generation prefer early planted cornfields as oviposition sites. The larvae (1st generation) move into the whorl, feed on the whorl leaves until the third instar of their development, and then bore into the corn stalks where they feed until they pupate. First generation ECB usually occur in Illinois during June.

Moths laying eggs for the second generation prefer later maturing corn with fresh silks as oviposition sites. Eggs are usually deposited on the underside of leaves between the ear zone and the tassel. Larvae (2nd generation) emerge and initially feed on pollen trapped in the collar regions where the leaves meet the stalk. More mature larvae bore into the stalks or ear shanks or tunnel inside the ears. Second generation ECB usually occur in Illinois during July and August, depending on geographical region. Yield losses from larval feeding damage can result from combinations of reduced plant vigor, stalk breakage, and ear drop.

One of the difficulties of managing ECB is timing insecticide evaluations when ECB reach an economic threshold. If control measures are necessary, insecticides must be applied before the larvae bore into the

stalks. For control of 1st generation borers, insecticides should be applied while the larvae are still feeding in the whorls of the corn plants. Guidelines in Illinois suggest treatment when 50 percent of the plants show signs of whorl feeding and larvae are still present in the whorls. For control of 2nd generation borers, the "treatment window" guideline is to apply an insecticide when a threshold of 0.5 egg mass per plant is reached. Timing of treatments for 2nd generation ECB is usually more difficult and the level of control achieved is usually not as good as that expected for control of 1st generation ECB.

Investigators at the University of Illinois and the Illinois Natural History Survey established insecticide plots on the Kern Brothers' Farm near Eureka, Illinois, and on the Cremer Farm near Minonk, Illinois, in June to evaluate Dipel 10G and Lorsban 15G for control of 1st generation ECB larvae. In August, a third insecticide plot was established in a field farmed by John Obery near Cruger, Illinois, to evaluate Dipel ES and Lorsban 4E for control of 2nd generation ECB larvae.

METHODS

1st generation ECB Aerial Insecticide Study - Kern Brothers' Farm

On 17 June, 1986, pre-treatment ECB counts were recorded in a cornfield that was 1/4 mile wide by 1/2 mile long on the Kern Brothers' Farm near Eureka, Illinois. Twelve samples of 25 plants each were examined in representative areas of the field. Two plants from each sample of 25 plants were examined to determine the number of larvae present. Whorl-feeding damage was detected in approximately 34 percent of the plants examined, and an average of 2.21 larvae/plant, primarily 2nd and 3rd instars, were present in the whorls. Even though the ECB population was below the economic threshold in Illinois, this field was selected because the entire field (approximately 70 acres) was planted with one hybrid (Pioneer 3377), and it is often difficult to find fields this large planted with just one number.

Nine plots approximately 130 feet wide by 1/2 mile long were established. Treatments were assigned to the plots using a randomized complete block design with 3 replications. The treatments, Dipel 10G and Lorsban 15G, were applied aerially in 66-foot wide swaths (2 passes per plot) on 18 June, 1986. An untreated check was included in each replication.

Unfortunately, an error was made when Dipel 10G was loaded into the hopper of the airplane that made the applications. Blank granules, intended for calibration purposes, were inadvertently mixed in with the actual product prior to application. As a result, the actual amount of product applied was diluted by 10-20 percent. The data for Dipel 10G are still presented in this report but should be viewed appropriately.

On 28 July, 1986, post-treatment data were collected. Ten consecutive plants in 4 representative areas of each plot were examined to determine the number of ECB cavities per plant and the percentage of plants with cavities. Ten consecutive plants in two other areas of each plot were also examined to determine the number of larvae per plant and the percentage of plants infested.

On 7 October, 1986, yield data were collected. Six rows of corn the length of the field were harvested from each plot. One grain truck was loaded from each plot, weighed with the corn, and weighed without the corn in order to determine the net weight for each sample. The percentage moisture was determined for each load of corn and yields are reported as bushels per acre of #2 corn adjusted to 15.5 percent moisture.

1st generation ECB Aerial Insecticide Study - Cremer Farms

A second 1st generation study was established to evaluate Dipel 10G applied at the proper rate per acre. On 24 June, 1986, pre-treatment samples were recorded in a field that measured 800 feet wide by 1/2 mile long on the Don Cremer Farm near Minonk, Illinois. Samples were recorded as previously described. Approximately 49 percent of the 300 plants sampled showed symptoms of whorl feeding, and closer examination of 24 of these plants revealed that nearly 1.85 larvae/plant were present in the whorls.

Several other fields had been examined before this location was chosen, but larvae had moved out of the whorl in many fields and had bored into the plants. This field was selected, even though there was more than one hybrid present (DeKalb T-1100, 636, and 572), because larvae were still in the whorl and because control was warranted.

Aerial treatments of Dipel 10G were applied on 25 June, 1986. The experimental design was identical to the one employed in the previous study except that Lorsban 15G was not included in the test. Post-treatment samples were evaluated on 28 July, 1986. No yield data were taken for this study.

2nd generation ECB Aerial Insecticide Study - Obery Farms

On 31 July, 1986, pre-treatment counts were recorded in a field farmed by John Obery near Cruger, Illinois. Fifty-one percent of the plants examined contained at least one ECB egg mass, right at the threshold of 0.5 egg mass per plant. Two hybrids, Pioneer 3377 and Cargill 947, were planted in this field. Mr. Obery had applied Lorsban 15G, Dyfonate 20G, and Counter 15G at planting time to different areas of the field for corn rootworm control.

Dipel ES and Lorsban 4E were aerially applied to the plots on 1 August, 1986. The experimental design was identical to that employed in the 1st-generation studies.

On 2 and 3 October, 1986, damage data were recorded in the plots. Four representative samples of 10 consecutive plants were examined in each plot. The number of larvae per plant and the percentage of plants infested were recorded for each sample. In addition, the number of larvae recovered from the ear shank and the ear were recorded, as well as the percentage of ears on the ground due to ear drop or stalk breakage.

RESULTS AND DISCUSSION

A summary of the results from the 1st generation studies is presented in Tables 17 and 18. The summary for the 2nd generation study is presented in Table 19.

1st Generation Study - Kern Brothers' Farm: Both Dipel 10G and Lorsban 15G significantly reduced the number of cavities/plant when compared to the number of cavities in the untreated check. Dipel 10G reduced the number of cavities by nearly 85 percent, and Lorsban 15G reduced the number of cavities by nearly 79 percent. Similarly, the mean number of larvae/plant was significantly lower for both the Dipel 10G and Lorsban 15G plots when compared to the untreated checks. Dipel 10G reduced the number of larvae per plant by nearly 79 percent and Lorsban 15G reduced the number of larvae per plant by almost 77 percent.

Statistical analyses were not conducted on yield samples. However, the data reveal a 6-7 bushel-per-acre increase in yield in plots treated with Dipel 10G and Lorsban 15G when compared to the untreated plots.

1st Generation Study - Cremer Farm: Dipel 10G significantly reduced the number of cavities/plant by 47 percent when compared to the untreated check (Table 18). The number of larvae per plant in the plots treated with Dipel 10G was smaller then the number of larvae per plant in the untreated check, but the difference was not significant.

2nd Generation Study - Obery Field: The mean number of larvae per plant was significantly lower in the plots treated with both Dipel ES and Lorsban 4E than in the untreated check (Table 19). Dipel ES was significantly better than Lorsban 4E in this same comparison. Dipel ES reduced the percentage of infested plants by nearly 21 percent, and Lorsban 4E reduced the percentage of infested plants by almost 7 percent when compared to the untreated check. Both Dipel ES and Lorsban 4E significantly reduced the number of larvae recovered from ear shanks and ears. Finally, plots treated with Dipel ES had nearly 67 percent fewer ears on the ground due to ear drop and stalk breakage, and plots treated with Lorsban 4E had about 33 percent fewer ears on the ground.

CONCLUSIONS

Both Dipel 10G and Lorsban 15G, when aerially applied for 1st generation ECB control in our plots, reduced the number of the cavities/plant and the number of larvae/plant. In one study this reduction in the level of infestation seemed to have resulted in a 6-7 bushel per acre yield advantage, although yield data were not statistically analyzed. Whether it would have paid a producer to treat for ECB in these studies is difficult to determine, especially with corn prices as low as they were during 1986. Despite this, corn producers can be encouraged by the results of the 1st-generation control studies because these products produced significant reductions in damage in the field. When corn prices rebound, there will be increased incentives to scout and to treat fields with economically damaging ECB populations.

Even though no yield data were recorded for the 2nd generation control study, John Obery reported that there were differences in the yields between the treated and untreated portions of the field. Both Dipel ES and Lorsban 4E significantly reduced the amount of damage to the corn and the number of ears lying on the ground in this field. As a result, many corn producers may want to spend more time monitoring their fields for 2nd generation ECB and treating when necessary to avoid costly damage and yield reductions.

LITERATURE CITED

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Steffey, K., D. Kuhlman, and S. Briggs. 1987. Economics of European corn borer control. In Proc. Ill. Agr. Pesticides Conf. '87, p. 188-194. Coop. Ext. Serv., Univ. of Illinois, Urbana-Champaign.

Table 17. Data summary for control of 1st generation European corn borer with aerial applications of Dipel 10G and Lorsban 15G at Kern Bros. Farms, Woodford County, near Eureka, Illinois, 1986.

Product	Rate[1]	Mean number cavities per plant[2]	Percentage plants with cavities	Mean number larvae per plant[2]	Percentage plants infested	Yield[3]
Dipel 10G	10.0	0.13 a	7.5	0.15 a	11.7	195.9
Lorsban 15G	7.0	0.24 a	10.6	0.15 a	13.3	195.0
Check	...	**1.00 b**	49.2	**0.82 b**	56.7	188.9

[1] Rate in pounds of product per acre. Dipel 10G rate diluted by 10-20% (see text for details).

[2] Means in a column followed by the same letter are not significantly different (DMRT; p=0.1). Original data were transformed by square root of (y + 0.5) before ANOVA.

[3] Yield is reported as bushels per acre. Samples include 6 rows of corn harvested the length of the field.

Table 18. Control of 1st generation European corn borer with an aerial application of Dipel 10G on Cremer Farms, Woodford County, near Minonk, Illinois, 1986.

Product	Rate[1]	Mean number cavities per plant[2]	Percentage plants with cavities	Mean number larvae per plant[2]	Percentage plants infested
Dipel 10G	10.0	0.36 a	27.5	0.37 a	30.0
Check	...	0.95 b	51.7	0.57 a	32.0

[1] Rate in pounds of product per acre.

[2] Means in a column followed by the same letter are not significantly different (DMRT); p=0.1). Original data were transformed by square root of (y + 0.5) before ANOVA.

Table 19. Control of 2nd generation European corn borer larvae with aerial applications of Dipel ES and Lorsban 4E on Obery Farms, Tazewell County near Cruger, Illinois, 1986.

Product	Rate[1]	Mean number larvae per plant[2]	Percentage plants infested	Mean number larvae found in the ear and ear shank[2]	Percentage ears on ground
Dipel ES	0.25	1.28 a	71.7	0.21 a	2.5
Lorsban 4E	0.25	1.71 b	84.2	0.25 a	5.0
Check	...	2.23 c	90.0	0.39 b	7.5

[1] Rate in gallons of product per acre.

[2] Means in a column followed by the same letter are not significantly different (DMRT; p=0.1). Original data were transformed by square root of (y + 0.5) before ANOVA.

EXPERIMENTS THAT MISFIRED

1st Generation European Corn Borer Study (Artificail Infestation)

Products:

Ambush 2EC - ICI Americas
Asana 1.9EC - DuPont
Baythroid .375G - Mobay
Dipel 10G - Abbott Labs
Dyfonate 20G - Stauffer
Furadan 15G - FMC
Furadan 4F - FMC
Furadan 90DB/WSB (water soluble pouch) - FMC
FMC-67825 20G - FMC
Pounce 1.5G - FMC

Investigators artificially infested corn plants with European corn borer larvae and planned to treat the plots several days after the larvae had established. On the morning that we had planned to apply the insecticide treatments, a considerable amount of rain fell. Five days elapsed before the soil was dry enough for us to drive our ground-operated equipment through the field. By that time the corn had grown so much that the equipment we intended to use in the plot would not clear the tops of the infested plants, so this study was abandoned.

We then located some late-planted corn and again infested the plants with corn borer larvae. Unfortunately, this field was also attractive to moths laying eggs for the second generation of larvae, so the field became heavily infested with a naturally occuring population of corn borers. Because we had no way to determine which generation of larvae was responsible for the damage in the plots, this study was also abandoned.

Seedcorn Maggot Study

Products:

Agrox seed treatment - Chipman
Counter in furrow - American Cyanamid
Germate seed treatment - Kalo
Magnum seed treatment - Gustafson
TF-3643 seed treatment - Chipman
TF-3721 seed treatment - Chipman
Oftanol seed treatment - Mobay

A small field (1/4 acre) was surface-dressed with manure on 27 May, 1986, to attract adult seedcorn maggots. All seed treatments and Counter 15G were applied at planting time on 1 June. After the corn had emerged, stand counts were recorded in the plots on two separate occasions. There was no evidence that seedcorn maggots had infested this plot, so no further evaluations were made.

Wireworm Study

Products:

Agrox seed treatment - Chipman
Counter 7-inch band - American Cyanamid
Escort - Gustafson
Furadan 7-inch band - FMC
Germate seed treatment - Kalo
Lorsban 7-inch band - Dow
Magnum seed treatment - Gustafson
TF-3643 seed treatment - Chipman
TF-3721 seed treatment - Chipman

A small field of corn (about 1 acre) was planted no-till into alfalfa and grass sod on 14 May, 1986, to evaluate products for control of wireworms. Stand-count data indicated that wireworm damage had not occured in the untreated checks. As a result, no further evaluations were conducted.

APPENDIX A

CLIMATE AND SOILS INFORMATION FOR THE INSECTICIDE EVALUATION PLOTS

Appendix A-1. Climate information for the spring insecticide evaluations at the University of Illinois, Urbana-Champaign, Illinois.[1]

	May 1986			June 1986			July 1986	
Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches
01	47/66	0.00	01	52/89	0.00	01	62/75	0.76
02	40/59	0.00	02	52/71	0.00	02	60/77	0.00
03	35/64	0.00	03	47/80	0.00	03	59/79	0.00
04	41/75	0.00	04	59/87	0.06	04	61/85	0.00
05	54/83	Trace	05	66/80	0.90	05	67/87	0.00
06	60/87	0.37	06	66/82	0.38	06	67/89	0.00
07	59/84	0.00	07	69/83	0.05	07	67/92	0.00
08	54/83	0.00	08	64/86	0.00	08	71/90	0.00
09	54/78	0.00	09	63/78	0.02	09	68/85	0.02
10	50/83	0.00	10	70/86	0.26	10	66/86	1.93
11	59/70	0.02	11	64/86	0.00	11	70/82	0.20
12	58/80	0.00	12	52/65	Trace	12	70/83	0.32
13	54/82	0.08	13	51/84	0.00	13	71/86	0.02
14	54/80	0.00	14	61/82	0.17	14	68/85	0.92
15	60/74	0.36	15	63/87	0.00	15	69/90	0.00
16	57/80	0.02	16	62/88	0.00	16	73/93	0.00
17	63/83	0.22	17	55/77	0.00	17	74/93	0.00
18	47/64	0.15	18	50/82	0.00	18	71/93	0.00
19	42/61	0.00	19	90/61	0.00	19	72/94	0.00
20	40/63	0.00	20	65/95	0.00	20	66/88	0.00
21	42/65	0.00	21	66/94	0.00	21	62/86	0.00
22	42/75	0.00	22	70/92	0.00	22	63/87	0.00
23	49/75	0.00	23	62/83	0.00	23	65/88	0.00
24	53/80	0.00	24	52/78	0.00	24	65/89	0.01
25	59/75	0.00	25	46/80	0.00	25	72/93	Trace
26	61/66	0.22	26	53/90	0.00	26	67/87	0.00
27	60/76	0.00	27	69/93	1.17	27	65/89	0.00
28	59/78	0.60	28	68/88	0.00	28	71/92	0.10
29	62/80	0.68	29	68/86	0.00	29	66/87	Trace
30	61/82	0.00	30	63/80	1.27	30	59/86	0.00
31	62/85	0.00				31	65/85	0.42
av	53/75	Tot=2.72	av	60/84	Tot=4.28	av	67/87	Tot=4.70

[1] All climate data were obtained from the National Weather Service reporting station at Urbana, Illinois.

Appendix A-2. Climate information for the fall black cutworm insecticide evaluations at the University of Illinois, Horticulture Vegetable Crops Farm, Urbana, Illinois.[1]

	August 1986			September 1986			October 1986	
Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches
01	57/84	0.00	01	54/81	0.00	01	64/74	0.86
02	64/84	0.00	02	63/81	0.00	02	61/74	0.02
03	58/82	0.00	03	60/82	0.00	03	71/74	0.23
04	57/78	0.00	04	64/83	0.03	04	58/76	0.04
05	61/80	0.00	05	58/86	0.00	05	46/78	0.00
06	65/83	0.04	06	52/82	0.00	06	40/75	0.00
07	61/77	0.12	07	50/74	0.01	07	35/60	0.00
08	64/79	0.00	08	37/68	0.00	08	46/73	0.00
09	69/88	0.00	09	44/74	0.00	09	52/77	0.08
10	67/86	0.68	10	58/80	0.00	10	41/61	0.00
11	59/82	0.00	11	70/89	0.14	11	45/66	0.00
12	54/77	0.00	12	56/78	0.54	12	53/73	0.15
13	56/78	0.00	13	45/74	0.00	13	44/57	0.08
14	56/78	0.00	14	52/81	0.00	14	33/46	0.08
15	54/87	0.00	15	58/84	0.00	15	31/50	0.00
16	66/80	0.05	16	52/83	0.00	16	35/59	0.00
17	60/83	0.00	17	47/71	0.00	17	35/62	0.00
18	65/88	0.00	18	54/78	0.53	18	37/57	0.00
19	60/85	0.00	19	59/73	0.04	19	39/63	0.00
20	59/85	0.00	20	64/73	2.26	20	45/68	0.00
21	61/86	0.00	21	64/79	0.62	21	46/72	0.00
22	60/85	0.00	22	65/91	0.00	22	46/75	0.00
23	67/87	0.01	23	64/88	0.70	23	50/72	0.00
24	52/81	0.02	24	64/73	0.31	24	55/62	0.23
25	55/80	0.00	25	68/83	0.11	25	53/58	0.80
26	66/87	0.10	26	70/88	0.00	26	51/58	0.34
27	62/92	0.44	27	63/87	0.70	27	48/54	0.19
28	43/80	0.00	28	64/85	0.00	28	42/60	0.02
29	44/67	0.00	29	72/90	0.00	29	49/67	0.01
30	45/73	0.00	30	64/87	1.23	30	41/60	0.00
31	48/78	0.00				31	38/60	0.00
av	59/82	Tot=1.46	av	59/81	Tot=7.22	av	46/65	Tot=3.13

[1] All climate data were obtained from the University of Illinois, Agronomy South Farm, Urbana, Illinois.

Appendix A-3. Climate information for the corn rootworm insecticide evaluation at Bloomington, Illinois, McLean County.[1,2]

	May 1986			June 1986			July 1986	
Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches
01	49/72	0.00	01	64/90	0.00	01	64/82	0.00
02	40/64	0.00	02	49/90	0.00	02	61/76	0.65
03	35/64	0.00	03	46/80	0.00	03	58/80	0.00
04	51/75	0.00	04	66/84	0.00	04	67/88	0.00
05	57/80	0.00	05	68/81	0.12	05	73/90	0.00
06	67/83	0.00	06	62/80	2.60	06	74/90	0.00
07	61/84	0.30	07	68/84	*.**[3]	07	72/90	0.00
08	51/85	0.00	08	65/85	*.**[3]	08	74/90	0.00
09	54/84	0.00	09	58/84	0.50	09	70/83	0.65
10	50/83	0.00	10	70/86	0.00	10	64/87	0.60
11	65/81	0.00	11	73/85	0.00	11	68/87	0.55
12	60/82	0.00	12	57/82	0.00	12	69/83	*.**[3]
13	57/80	0.00	13	56/86	0.00	13	68/88	*.**[3]
14	51/79	0.08	14	61/83	0.00	14	68/87	2.00
15	60/76	0.00	15	64/84	0.00	15	70/90	0.10
16	54/79	0.31	16	70/88	0.35	16	73/92	0.00
17	55/79	0.00	17	55/87	0.00	17	70/93	0.00
18	50/78	0.75	18	60/82	0.00	18	70/95	0.00
19	47/61	0.00	19	65/92	0.00	19	76/95	0.00
20	37/64	0.00	20	68/95	0.00	20	71/92	0.00
21	39/68	0.00	21	72/95	0.00	21	63/83	0.00
22	48/74	0.00	22	72/92	0.00	22	66/88	0.00
23	45/75	0.00	23	66/85	0.00	23	66/89	0.00
24	51/79	0.00	24	60/82	0.00	24	73/90	0.00
25	58/78	0.00	25	47/80	0.00	25	74/92	0.00
26	58/78	1.40	26	66/90	0.00	26	66/88	0.00
27	61/74	0.00	27	90/75	0.00	27	68/91	0.00
28	57/77	0.00	28	70/89	*.**[3]	28	68/90	0.10
29	63/80	0.38	29	67/86	2.30	29	69/90	0.00
30	59/83	0.00	30	60/82	0.39	30	65/87	0.00
31	61/85	0.00				31	66/87	1.05
av	53/77	Tot=3.22	av	63/86	Tot=6.26	av	68/88	Tot=5.31

[1] All temperature data were obtained from the National Weather Service reporting station at Normal, Illinois.

[2] Rainfall data were recorded on-site for the insecticide plot in Bloomington, Illinois.

[3] Rainfall data were not recorded on this date and are included as accumulative total on the next reporting date.

Appendix A-4. Climate information for the corn rootworm insecticide evaluation at Bolton, Illinois, Stephenson County.[1]

	May 1986			June 1986			July 1986	
Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches
01	46/82	0.01	01	68/87	0.00	01	54/65	0.00
02	37/60	0.00	02	41/86	0.00	02	55/67	0.00
03	31/59	0.00	03	40/66	0.00	03	53/80	Trace
04	36/66	0.00	04	48/79	0.00	04	56/81	0.00
05	51/81	0.00	05	55/85	0.03	05	73/90	0.00
06	57/80	0.07	06	55/65	Trace	06	71/91	0.00
07	46/80	0.00	07	59/71	0.20	07	63/89	0.60
08	44/79	0.00	08	63/83	Trace	08	63/73	0.03
09	46/75	0.00	09	50/82	0.00	09	65/87	1.23
10	49/78	0.00	10	53/82	0.04	10	55/77	0.00
11	56/81	0.00	11	63/87	0.12	11	58/75	0.50
12	56/72	0.13	12	51/84	0.06	12	63/82	0.10
13	48/71	Trace	13	54/71	Trace	13	58/85	Trace
14	51/75	1.50	14	54/79	0.08	14	58/84	0.00
15	49/71	Trace	15	55/63	0.00	15	60/83	0.11
16	54/69	0.37	16	56/74	0.47	16	62/90	Trace
17	58/75	0.70	17	49/80	0.00	17	71/94	0.00
18	45/66	1.16	18	49/77	0.00	18	73/94	0.00
19	44/66	0.00	19	59/86	0.00	19	74/94	0.00
20	35/60	0.00	20	63/93	0.00	20	64/93	0.08
21	38/63	0.00	21	67/87	0.00	21	59/86	0.00
22	40/69	0.00	22	65/92	0.17	22	60/85	0.00
23	44/60	0.00	23	53/84	0.10	23	58/88	0.00
24	48/69	0.00	24	53/84	0.13	24	64/89	0.00
25	53/69	Trace	25	44/71	0.00	25	66/93	0.22
26	55/75	0.01	26	48/78	0.00	26	66/86	0.04
27	55/69	0.92	27	65/91	Trace	27	64/86	0.00
28	56/63	0.02	28	67/79	0.40	28	60/89	0.08
29	57/75	0.03	29	65/84	0.00	29	63/88	0.00
30	55/80	Trace	30	54/83	0.81	30	58/86	0.00
31	63/81	0.00				31	60/85	0.00
av	47/72	Tot=4.92	av	56/80	Tot=2.61	av	62/85	Tot=2.99

[1] All climate data were obtained from the National Weather Service reporting station at Freeport, Illinois.

Appendix A-5. Climate information for the corn rootworm insecticide evaluation at Henry, Illinois, Marshall County.[1]

May 1986			June 1986			July 1986		
Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches
01	53/73	1.81	01	67/87	0.00	01	62/71	0.02
02	40/63	0.00	02	48/90	0.00	02	59/68	1.33
03	36/60	0.00	03	47/71	0.00	03	57/77	0.00
04	41/66	0.00	04	58/80	0.00	04	61/81	0.00
05	63/80	0.00	05	67/84	0.17	05	71/88	*.**[2]
06	68/83	Trace	06	60/74	0.01	06	72/90	*.**[2]
07	60/81	0.00	07	62/77	0.05	07	68/90	0.53
08	49/80	0.00	08	62/83	0.05	08	70/85	0.09
09	62/84	0.00	09	57/85	0.00	09	68/88	1.13
10	56/77	0.00	10	65/80	2.80	10	62/85	0.24
11	55/84	Trace	11	73/87	0.00	11	68/87	0.52
12	60/73	0.02	12	55/82	0.00	12	67/82	0.24
13	56/82	0.00	13	58/69	0.00	13	65/83	0.05
14	54/79	0.83	14	61/81	0.00	14	68/86	Trace
15	56/77	0.02	15	59/70	0.78	15	69/90	0.00
16	58/71	0.25	16	64/80	0.00	16	73/89	0.00
17	60/76	0.33	17	55/87	0.00	17	74/92	0.00
18	49/73	1.48	18	57/79	0.00	18	73/92	0.00
19	49/63	0.01	19	63/82	0.00	19	73/93	0.00
20	38/65	0.00	20	70/92	0.00	20	70/93	0.00
21	40/63	0.00	21	67/93	0.00	21	63/85	0.00
22	41/68	0.00	22	75/92	0.00	22	63/88	0.00
23	55/69	0.00	23	59/86	0.00	23	62/87	0.00
24	50/75	0.00	24	58/82	0.00	24	66/89	0.00
25	55/75	0.02	25	45/77	0.00	25	68/90	0.35
26	57/79	0.19	26	59/79	0.00	26	65/86	0.00
27	59/67	1.02	27	74/90	0.00	27	85/65	0.00
28	58/74	0.00	28	68/88	1.03	28	74/90	0.00
29	60/77	0.37	29	64/87	0.00	29	90/67	0.00
30	62/81	0.00	30	60/83	2.10	30	63/88	*.**[2]
31	63/82	0.00				31	62/89	0.23
av	54/74	Tot=6.35	av	61/83	Tot=6.99	av	67/86	Tot=4.73

[1] All climate data were obtained from the National Weather Service reporting station at Lacon, Illinois.

[2] Rainfall data were not recorded on this date and are included as a cumulative total on the next reporting date.

Appendix A-6. Climate information for the corn rootworm insecticide evaluation at the University of Illinois Northwest Agronomy Research Center, Monmouth, Illinois.[1]

	May 1986			June 1986			July 1986	
Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches	Day	Temp °F min/max	Rainfall inches
01	48/67	0.52	01	63/84	0.00	01	63/83	0.01
02	47/69	0.00	02	46/88	0.00	02	58/68	0.70
03	36/60	0.00	03	48/71	0.00	03	54/79	0.00
04	47/68	0.00	04	48/80	0.03	04	66/83	0.00
05	47/68	0.00	05	65/83	0.34	05	71/88	0.00
06	59/82	0.10	06	62/70	0.20	06	72/89	0.00
07	56/77	0.27	07	67/78	0.50	07	70/88	0.02
08	54/80	0.02	08	66/83	0.00	08	71/82	0.06
09	57/82	0.00	09	59/81	0.00	09	69/89	1.00
10	57/75	0.00	10	63/80	0.10	10	62/83	0.19
11	59/76	0.02	11	67/89	0.00	11	66/83	0.10
12	55/73	0.00	12	54/81	0.04	12	65/82	1.41
13	61/83	0.00	13	54/74	0.00	13	63/82	0.01
14	50/80	0.09	14	61/82	0.00	14	64/85	0.00
15	57/77	0.05	15	62/72	0.35	15	70/86	0.00
16	52/70	0.11	16	64/81	0.00	16	71/89	0.00
17	59/74	1.62	17	53/86	0.00	17	71/91	0.00
18	52/72	1.13	18	61/81	0.00	18	70/89	0.00
19	46/65	0.00	19	65/86	0.00	19	72/91	0.00
20	50/64	0.00	20	64/92	0.00	20	70/93	0.00
21	39/65	0.00	21	68/91	0.00	21	63/83	0.00
22	45/68	0.00	22	68/91	0.05	22	60/84	0.00
23	47/70	0.00	23	57/84	0.21	23	60/86	0.00
24	47/73	0.00	24	56/81	0.00	24	69/87	0.00
25	54/75	0.00	25	51/76	0.00	25	68/88	0.27
26	57/77	0.55	26	59/80	0.00	26	64/86	0.00
27	58/63	0.27	27	73/91	0.00	27	65/84	0.00
28	56/73	0.00	28	69/87	0.16	28	68/87	0.00
29	60/73	0.01	29	65/88	0.00	29	64/90	0.27
30	58/79	0.02	30	65/79	1.13	30	66/86	0.00
31	60/80	0.00				31	68/85	1.49
av	53/73	Tot=4.78	av	61/82	Tot=3.11	av	66/86	Tot=5.53

[1] All climate data were obtained from the National Weather Service reporting station at Monmouth, Illinois.

Appendix A-7. Climate information for the corn rootworm biological evaluation, University of Illinois South Annex, Urbana, Illinois.[1]

Date	Rainfall inches	Air Temperature °F min/max	Soil Temperature °F 2" min/max	4" min/max	6" min/max
May					
01	0.00	48.4/65.8	49.5/69.3	51.5/65.5	52.9/60.9
02	0.00	43.7/57.6	49.2/61.1	51.4/58.5	53.4/57.4
03	0.00	37.8/63.6	46.6/66.0	48.8/62.2	51.1/59.3
04	0.00	42.3/74.3	50.4/65.0	51.9/63.4	53.3/59.8
05	Trace	54.9/81.9	54.1/68.3	55.1/65.6	55.4/61.6
06	0.37	60.7/86.1	63.2/74.6	62.1/70.9	60.5/65.8
07	0.00	60.1/83.2	62.6/77.1	62.3/72.6	61.7/68.1
08	0.00	55.1/82.8	58.7/74.6	60.2/71.7	61.1/67.7
09	0.00	55.5/77.9	59.7/73.9	61.0/71.9	61.6/67.9
10	0.00	51.6/82.3	58.9/74.7	60.3/72.2	61.1/68.1
11	0.02	61.2/71.7	63.7/68.1	63.8/66.7	63.3/66.1
12	0.00	60.4/80.1	63.5/77.5	63.5/73.7	63.0/69.4
13	0.08	56.3/82.0	62.3/74.9	63.2/72.2	63.4/68.1
14	0.00	55.0/77.4	61.2/74.8	62.4/72.5	62.8/68.6
15	0.36	61.0/73.0	63.7/67.4	64.0/66.3	63.7/66.3
16	0.02	57.7/78.6	60.9/74.1	61.7/71.0	62.2/68.0
17	0.22	63.6/81.5	65.0/71.2	65.1/69.6	64.9/67.6
18	0.15	48.2/64.7	55.2/66.0	56.7/66.0	58.4/65.9
19	0.00	43.2/59.5	51.4/60.4	53.6/59.6	56.4/59.3
20	0.00	40.5/63.1	48.3/62.4	50.5/60.2	53.1/58.6
21	0.00	44.0/65.4	50.7/66.3	52.2/63.9	53.9/60.6
22	0.00	45.2/73.2	52.8/70.7	54.2/67.7	55.9/63.2
23	0.00	49.7/75.1	55.4/74.3	56.7/70.8	57.5/66.0
24	0.00	55.0/80.3	59.7/76.9	60.3/73.1	60.5/68.0
25	0.00	61.7/74.3	63.4/73.3	63.6/71.6	63.2/67.8
26	0.22	61.4/65.5	64.4/66.3	64.3/66.5	63.7/65.8
27	0.00	62.9/76.3	63.8/73.8	63.6/71.4	63.2/67.9
28	0.60	62.0/79.0	63.2/71.9	63.6/70.3	63.7/67.4
29	0.68	64.0/77.7	65.6/77.1	65.6/73.3	65.3/70.4
30	0.00	62.9/81.6	64.6/79.2	65.1/74.9	65.5/71.6
31	0.00	63.2/85.1	65.3/81.8	66.0/78.3	66.5/73.7
	Total = 2.72	av = 54.5/74.9	58.6/71.4	59.5/68.8	60.1/65.7

1 All climate data were recorded on site.

Appendix A-8. Climate information for the corn rootworm biological evaluation, University of Illinois South Annex, Urbana, Illinois.[1]

Date	Rainfall inches	Air Temperature °F min/max	Soil Temperature °F 2" min/max	4" min/max	6" min/max
June					
01	0.00	53.7/89.2	66.5/84.3	68.1/80.1	68.2/75.4
02	0.00	53.5/71.4	62.8/77.2	64.8/74.4	65.8/71.5
03	0.00	49.4/78.6	59.4/81.9	61.8/77.1	63.2/72.7
04	0.06	61.4/85.8	66.5/82.0	67.0/77.8	66.9/73.4
05	0.90	66.3/80.2	69.3/77.3	69.7/74.3	69.6/72.2
06	0.38	66.3/81.1	68.5/80.0	68.6/76.4	68.4/73.6
07	0.05	69.8/81.6	71.2/78.9	71.0/76.0	70.5/73.8
08	0.00	65.6/85.0	69.0/83.4	69.5/78.7	69.8/75.9
09	0.02	63.5/76.7	65.7/74.4	67.3/72.1	68.2/72.5
10	0.26	70.0/85.4	70.0/80.4	69.7/76.4	69.5/74.0
11	0.00	66.4/85.1	70.0/79.6	71.6/76.7	71.5/74.7
12	Trace	55.4/66.7	62.6/70.0	64.9/71.6	66.5/72.3
13	0.00	53.4/83.9	59.9/82.9	62.2/77.8	63.9/73.5
14	0.17	62.4/81.9	67.2/80.0	68.3/76.7	68.6/73.7
15	0.00	65.1/85.1	69.0/81.6	69.6/77.3	70.0/74.7
16	0.00	62.9/88.3	69.9/86.0	70.4/81.4	70.5/77.5
17	0.00	57.9/77.2	65.8/87.6	68.3/81.0	69.3/77.1
18	0.00	53.2/80.2	65.6/85.3	67.8/80.2	68.7/76.4
	Total = 1.84	av = 60.9/81.3	66.6/80.7	67.8/77.0	68.3/74.2

[1] All climate data were recorded on site.

Appendix A-9. Soil analyses for the 1986 insecticide evaluations.

Item	LOCATION					
	Bloomington	Bolton	Henry	Monmouth	U of I S. Annex	U of I Cutworm
Soil PH	6.3	6.8	6.6	7.0	5.8	6.6
% OM	4.8	7.9	2.5	4.6	3.9	2.1
P1 lbs/A	77	219	106	71	310+	65
P2 lbs/A	NA	510	164	156	610	182
K lbs/A	371	675	412	287	1039	391
Ca lbs/A	NA	4550	2800	5230	3210	3320
Mg lbs/A	NA	930	630	540	530	400
Na lbs/A	NA	71	41	56	45	39
Soluble Salts Meg/cm	NA	0.5[1]	0.9[1]	0.4[1]	0.6[1]	0.3[1]
CEC Meg/cm	17.6	16.8	11.1	16.2	13.3	11.4
% Sand	NA	17.5	36.2	1.2	25.0	18.8
% Silt	NA	75.0	48.8	88.8	62.5	66.2
% Clay	NA	7.5	15.0	10.0	12.5	15.0
Class	NA	Silt loam	Loam	Silt	Silt loam	Silt loam

[1] Nonsaline: salinity effects mostly negligible.

NA (not available)

APPENDIX B

FORMULATION COMMENTS

Appendix B-1. Calibration and formulation comments about products included in the 1986 insecticide evaluations.

Product	Comments
Baythroid .375% G	Difficult to calibrate Noble units with this granule.
Furadan 15G 30/60	Difficult to calibrate Noble units with this granule.
Furadan 15G CG	Formulation lumpy upon arrival.
Furadan 15G CR10	Formulation seemed abrasive to Noble units.
Lance 15G	Formulation contained several large lumps upon arrival.
Magnum 90 seed treatment	Treated seed gummed up planter boxes.
Mocap 15G	Product arrived in badly damaged container.
PP-993	Two workers experienced minor nose and throat irritation while calibrating product even though respirators were used.
SC-0567 5G	Formulation arrived with some chunks and continued to attract humidity when stored in Noble units.
	Material was difficult to calibrate because it was extremely light.
	Very disagreeable odor.
SD-208304	Glass bottle containing blank granules was broken upon arrival. Please don't ship products in glass containers.
UBI-A920	Formulation contained a few lumps upon arrival.